REDUCING THE FLOOD DAMAGE POTENTIAL IN OCEAN CITY, MARYLAND

A Report
Prepared for the
Maryland Department of Natural Resources
By
IEP, Inc.
And
L.R. Johnston Associates

REDUCING THE FLOOD DAMAGE POTENTIAL IN OCEAN CITY, MARYLAND

April 1984

Prepared For

Department of Natural Resources
Tidewater Administration
State of Maryland

Prepared By

Stanley M. Humphries

IEP, Inc.
6 Maple Street
Northborough, Massachusetts

Larry R. Johnston

L. R. Johnston Associates
21 St. John Place
Westport, Connecticut

PREFACE

Coastal flood hazard vulnerability and the opportunities to mitigate the damages that result from a storm have changed substantially since March 6-8, 1962 when the last major storm impacted the mid-Atlantic States. Ocean City, Maryland is one of many developed barrier beaches in this region which faces an ever-increasing potential loss of life and property unless pre- and post-disaster planning is improved. The most recent government supported document providing information critical to understanding more about the problem in the Ocean City area is A Geographical Analysis of Fenwick Island, (Dolan, et al, 1980). It serves as a valuable resource in the continuing effort of assisting Ocean City, Worcester County and the State of Maryland in comprehensive disaster planning.

The purpose of this study is to summarize specific existing information on flood hazard vulnerability and identify measures that can be taken both before and after a major storm in addition to emergency management activities and efforts. The study also examines the effectiveness of the several beach protection plans recently proposed for Ocean City and how those plans relate to other nonstructural flood loss reduction measures.

Unlike other more costly hurricane preparedness studies that are based on the application of current computer models (e.g. SLOSH) or recently collected coastal process data, this study represents a lower cost effort designed to integrate existing scientific, legal and planning information, and recommend a set of general guidelines and criteria.

This study is sponsored by the Coastal Resources Division, Tidewater Administration, Maryland Department of Natural Resources with assistance

provided by other relevant state agencies, Worcester County Commissioners, the City Council of Ocean City and the City Manager's office of Ocean City. This project has been financed with federal funds from the Federal Emergency Management Agency under assistance agreement award identification number EMP-K-0065. The contents do not necessarily reflect the views and policies of the Federal Emergency Management Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

ACKNOWLEDGMENTS

This study was performed under the direction of Dr. Sarah Taylor and Mr. Earl Bradley of the Coastal Resources Division and members of the State's Post-Disaster Planning Task Force which includes: Ms. Marguerite Whilden, Water Resources Administration; Mr. Larry Fogelson, Office of State Planning; and Mr. John Peabody, Maryland Emergency Management and Civil Defence Agency. The staff of the Coastal Resources Division, specifically Dr. Christopher Zabawa, Mr. Jeffrey Hutchins, P.E. and Mr. David Burke, provided many services and much assistance during the course of the study.

Dr. Stephen Leatherman greatly contributed to the historical shoreline analysis, stratigraphic interpretation and geomorphic characterization.

Technical support, data refinement and data analysis was additionally provided by Mr. John Rohrer, Mr. Michael Rapacz and Mr. Andrew Miller of IEP, Inc. and Mr. Beach Clow of the University of Maryland.

EXECUTIVE SUMMARY

The Town of Ocean City, Maryland is an extensively developed resort community located on a coastal barrier beach along the Atlantic Ocean. Intensely developed with individual homes, commercial businesses, motels, mobile homes, and high-rise motels and condominiums, as well as being heavily populated in the summer months, Ocean City is subject to potentially high levels of damage from coastal storms and floods. Vulnerability to these hazards is particularly acute because of the geographic and geologic characteristics that define the long, low and narrow coastal barrier which the City occupies. This study was conducted in order to summarize existing hazard vulnerability, storm and beach protection alternatives, and land use ordinances and controls so that a set of actions could be recommended to reduce the flood damage potential before and after a storm. With the tremendous economic investments in Ocean City, there is a great need to reduce the damage potential. However, with the present level of development and strong pressures for continued development and redevelopment, the opportunities for mitigation are limited and the cost will be high.

FLOOD HAZARD VULNERABILITY

Five general areas across the coastal barrier were analyzed in order to characterize the existing natural and built environment and to identify areas of greatest risk to flood and erosion processes. These five areas include: the nearshore zone; the shore zone; the high hazard zone, the 100-year floodplain and the bays. A steep offshore profile, established since the last major storm in 1962, will remain as long as the static shoreline position of the City is held. As a result, a major increase in beach recession can be expected during the next major storm. An eroding, low, narrow beach dotted with numerous ineffective groins only

provides protection from storms with approximately a 5-year return frequency. Very few sand dunes now exist along the Ocean City beachfront. They have been largely replaced by over 335 habitable structures and numerous parking lots. These buildings are exposed to waves greater than three feet during a 100-year storm. Essentially, the entire City is within the 100-year floodplain and historical photos of the 1962 storm (a 50-year event) show a majority of the major road through the City to be covered by overwashed sand. The threat of inlet formation is also considerable because of existing man-made canals and natural channels, barrier narrowness, previous inlet formations and several "buried valleys" that have been mapped. During a low frequency storm event, there is also a considerable hazard along the bay shoreline of Ocean City as a result of high water flowing back over the barrier toward the ocean.

Three broad areas that are at greatest risk and thus likely to suffer heavy damages during a major storm were identified based on a composite of natural and built characteristics. The area between 74th and 87th Streets is particularly vulnerable to erosion damage during high frequency minor storms (i.e., 10-year event) because of a narrow beach and low dunes. The area between 112th and 132nd Streets is particularly vulnerable to flooding damage during moderate frequency storms (i.e., 50-year event) because of a wide velocity zone. The area between 32nd and 57th Streets is particularly vulnerable to damages caused by inlet formation during low frequency storms (i.e., 100-year events) because of a narrow barrier width, several bayside channels, an historical inlet and a mapped "buried valley."

IS OCEAN CITY PREPARED?

Historically, Ocean City has provided storm and beach protection only on an emergency basis. Following the March 1962 storm, the beach and dunes

were reconstructed to provide 10-year storm protection. Small groins have been placed at various locations in response to localized erosion problems. In 1976 and 1978 lower portions of the beach in certain areas were bulldozed to create "dunes" which provided only immediate post-storm protection. Currently, the City and State are jointly funding the placement of a series of groins over the next 25 years which will provide protection against a 10-year storm event. The two most important features of the groin plan (besides the engineering specifications) are: (1) the groins must be placed sequentially from 9th Street northward to the Maryland-Delaware line; and, (2) each groin cell must be filled to capacity. There are currently limited efforts of the County Soil Conservation District and private citizens to reestablish and stabilize dunes.

Several agencies within the Maryland Department of Natural Resources have substantial responsibilities for administering State legislation and regulations that relate directly to flood hazard mitigation. Ocean City and Worcester County also have land use and construction regulations, some of which are related to State programs. These State and local regulations that currently govern Ocean City and the coastal portions of Worcester County generally provide at least a minimum protection from flood hazards when compared with national standards and regulations prevalent in coastal communities. But there is a need for modification and improvement to existing land use regulations and development controls to better define State and local roles and to provide more than minimum protection.

The City relies heavily upon its building code and floodplain regulations to ensure that buildings are designed and constructed to withstand the forces of wind and water during storms, but much of the present development occurred during the late 60's and mid 70's when many of the present land use and construction controls did not exist.

Enforcement of regulations appears not to have been uniform over the years, and perhaps most importantly, the special, changeable nature of Ocean City as a barrier island has not been fully recognized in most of the existing regulations and development decisions. Many Ocean City officials and residents/property owners believe that having survived one severe storm in 1962 they can fare equally well during the next major storm. There is little evidence to support the optimism. Ocean City is subject to more severe erosion and flooding than in 1962, much more property is at risk, and it is unclear whether the City can be evacuated in the available time. In summary, today Ocean City is more vulnerable to losses from a major hurricane or nor'easter than at any time in its past.

REDUCING DAMAGE POTENTIAL

Only limited structural and nonstructural flood hazard mitigation alternatives are available to Ocean City. Most of the attention over the last several years has focused on selecting and implementing a beach protection plan. Less attention has been given to the consideration of nonstructural measures such as improved elevation requirements, construction setbacks, land acquisiton and building code improvements. To effectively reduce the damage potential related to coastal storms, Ocean City must adopt a comprehensive flood hazard mitigation strategy which utilizes a combination of structural and nonstructural measures. Perhaps some measures can't be implemented until after a storm occurs; they should be considered and planned for before a storm.

Short-term, interim protection against beach erosion is currently being sought with a groin plan modeled after recommendations by Trident Engineering Associates. A beach nourishment plan providing much longer term protection against both erosion and flooding has been proposed by

the U.S. Army Corps of Engineers. A hybrid groin plan which incorporates features of all the Corps and Trident plans has been proposed by the State. While this groin plan will do little to directly reduce flood-related damages, it may provide a wider beach which is necessary for dune stabilization. Beach restoration and maintenance requirements of the plan must be fulfilled. As the groin plan is being implemented, the beach must be monitored and maintained and opportunities must be taken to construct dunes as required in the hybrid plan. This approach would provide more of a transition from strictly erosion protection to both erosion and flood protection. In short, a 50-year protection plan would be created.

Several changes should be made in the plans, programs and regulations that govern land use in Ocean City in order to recognize the changing nature of flood hazard vulnerability on a coastal barrier and to protect people and property over a long period of time. Revisions to the Comprehensive Plan For Ocean City, and Open Space Implementation Program, zoning regulations, erosion and sediment control regulations, the State-Ocean City Building Limit Line Authority and several construction standards need to be made. Some revisions can take place now, but some cannot be made until after a major storm occurs. In general, the suggested revisions focus on funding sources, public awareness, enforcement, and most importantly, the opportunities to establish specific standards as opposed to general performance standards. Of particular importance are the need to establish a set back provision and stringent foundation requirements for structures on the bay side of Ocean City, to provide greater setback from mean high water along the ocean front, and the adoption of a building code in Worcester County. Also essential is the development of a detailed, evacuation plan for Ocean City and nearby areas of Worcester County.

GUIDING REDEVELOPMENT

Ocean City needs to be better prepared for what will happen after a disasterous storm occurs: to prepare for recovery, restoration and mitigation. Such preparation will not eliminate the personal stress, economic loss and the effects of a disaster, but it will reduce some of the pressure to respond in the emergency and recovery phases and improve the efficiency of the relief effort. Disaster assistance policies, procedures and financial aid provided by the federal government as well as natural changes of the coastal barrier environment will, in part, control the decision-making process. Knowledge of these limitations and possible changes is an essential part of pre-disaster planning for post-disaster actions.

Establishment of necessary authorities and procedures must occur prior to a disaster and must address at least the following:

1. Revision of the Comprehensive Plan of Ocean City;
2. Authority to impose a temporary building moratorium;
3. Appointment of special teams and task forces;
4. Identification of outside products and services; and,
5. Sources of funding for disaster recovery and mitigation.

In addition, a Post-Disaster Recovery/Mitigation Plan should be prepared before the disaster to avoid unnecessary confusion, delay and inappropriate actions after the disaster. The purpose of the plan is to: 1) expedite recovery from the disaster while also identifying ways to mitigate future loss potential; 2) identify the actions that will be needed as well as the authority and criteria for these actions;
3) identify any special roles of officials and citizens; and,
4) identify types of outside assistance that will be required. The major actions recommended in the Plan are decribed in the following areas:

1. Emergency or Disaster Declaration;
2. Damage Assessments;
3. Beach and Dune Restoration; and,
4. Reconstruction Permitting.

LIST OF FIGURES

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

The Town of Ocean City, Maryland (see Figure 1) is located on a coastal barrier beach referred to as Fenwick Island that stretches along the Atlantic coasts of Delaware and Maryland. Ocean City occupies the entire section of barrier beach south from the Delaware line to Ocean City Inlet, which separates Ocean City from Assateague Island.

Ocean City has been a resort community since the 1800's and, during the last 15 to 20 years, has undergone explosive growth. Although the permanent population of Ocean City is still less than 6,000, the transient population is now estimated to exceed 250,000 on peak summer weekends. To accommodate this large number of visitors, Ocean City has been extensively developed with individual homes, commercial businesses, motels, mobile homes, and high-rise motels and condominiums.

As part of a growing national awareness of the storm and flood hazards to which coastal communities are subject, the Maryland Department of Natural Resources and the State Development Council chaired by the Department of State Planning has expressed increasing concern over the safety of the residents, visitors and property in Ocean City. It also recognized that Ocean City is already highly developed with a tremendous economic investment in new real estate and that there are only limited opportunities for reducing the flood loss potential of this existing development. Ocean City will continue to receive strong pressures for continued development and redevelopment because of its established position as a major east coast resort and its proximity to the major metropolitan areas of Washington, D.C. and Baltimore, Maryland. However, opportunities to control new growth will be explored.

To address these issues the Department of Natural Resources decided to sponsor a study that would evaluate the overall storm and flood hazard potential at Ocean City, and develop recommendations for actions that could be taken by the State, Worcester County and Ocean City to reduce

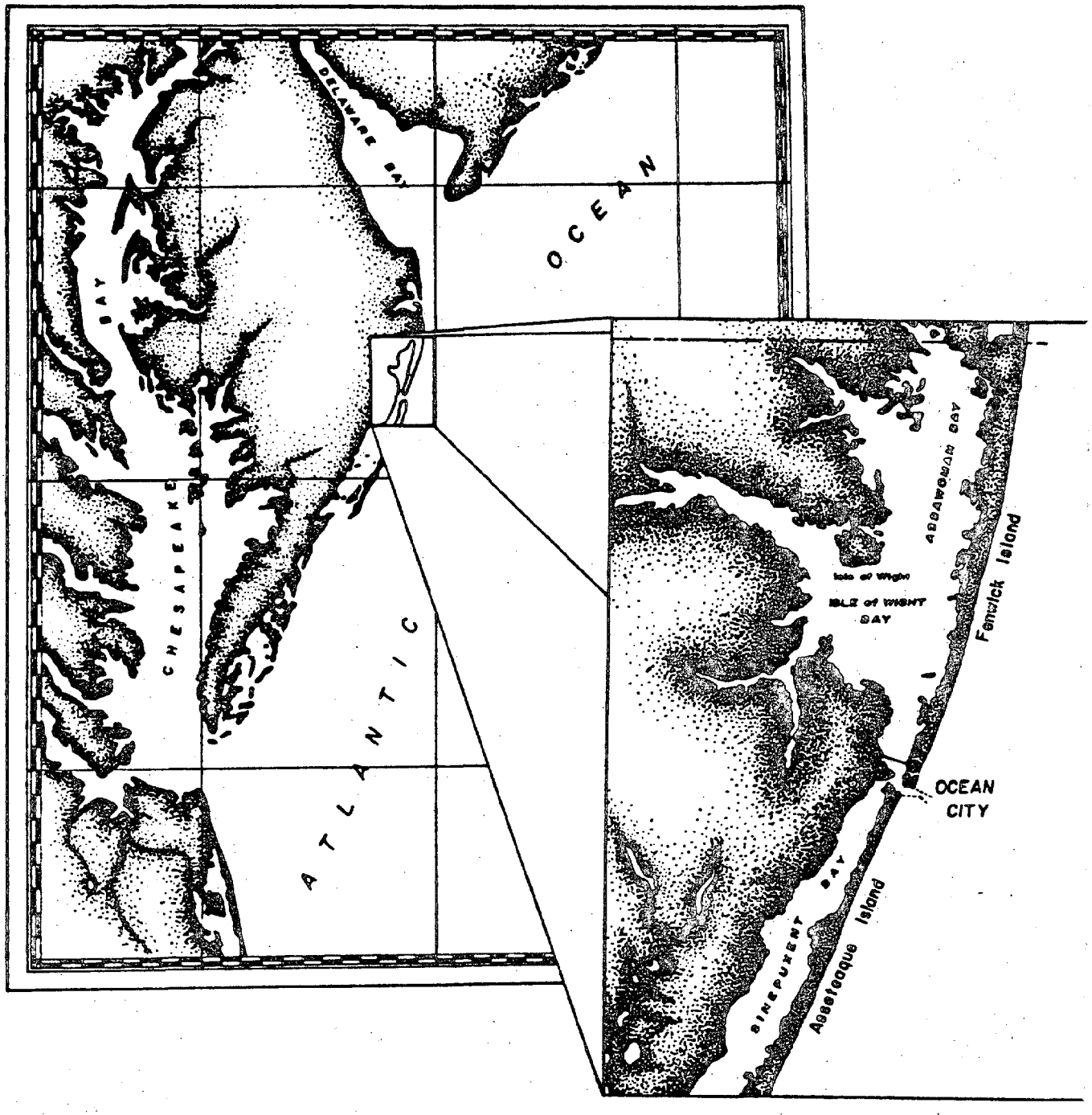


Figure 1. Location of Ocean City, Maryland.

the flood loss potential in the Ocean City area. The emphasis of the study would be on what should be done to prepare for recovery and redevelopment following a major natural disaster. In addition, the study was to examine the effectiveness of the several beach protection plans recently proposed for Ocean City and how those plans relate to other flood loss reduction (or hazard mitigation) measures.

Specific objectives of the planning study and the general approach to identifying additional hazard mitigation measures are described within the following five tasks:

1. Identify approaches and criteria for flood hazard mitigation that have been used or considered in other areas that may also be applicable to the Ocean City area;

2. Identify areas of greatest risk, areas likely to suffer heavy damage, areas of potential breaching and portions of the island that may be isolated due to major storm flooding and erosional processes;

3. Analyze four storm and beach protection alternatives regarding their effectiveness as beach protection and hazard mitigation measures, their costs and benefits and the implications of their implementation on other proposed hazard mitigation measures;

4. Determine what modifications may be appropriate to existing codes, ordinances, legislation plans, programs and other land use control and tax incentives; and,

5. Develop performance criteria that can be used by state, county and city officials in guiding relocation/redevelopment decisions and actions after a major storm has occurred.

UNDERSTANDING BARRIER BEACHES

Coastal barriers have been the subject of intense research over the past 15 years and, to date, three theories of origin are prevalent (Hayes and Kana, 1976). Classification schemes, including subclasses by shape, have been presented (Leatherman, 1982). Regional variations as a function of tidal range have been described (Hayes, 1979). Ecologic and geomorphic descriptions of individual barrier components, beach erosion and barrier inventories, as well as geological atlases, have been compiled in the last 10 years to serve as useful baseline information (Humphries and Benoit, 1980). Currently, research on sea-level rise is being conducted in several barrier environments (Titus et al, 1983). The overwhelming majority of these data demonstrates significant levels of flood hazard vulnerability, rates of landward movement or migration of barriar beaches and degrees of sensitivity to man-induced modifications that exist on most barrier beaches.

Efforts to improve public awareness and education concerning the hazards and costs of living on barriers require translation of that scientific research. The National Flood Insurance Program and the Coastal Zone Management Act are two primary mechanisms for bringing about and improving the understanding of scientific research for the general public. Among the many conferences and workshops that have presented information on barriers, the Barrier Islands Workshop in Annapolis, Maryland (1976) and the Barrier Island Forum and Workshop in Provincetown, Massachusetts (1980) were specifically devoted to expanding public awareness and changing management policies within the federal government. These educational efforts contributed to the passage of the Omnibus Budget Reconciliation Act of 1981 and the Coastal Barrier Resources Act of 1982 which curtail federal expenditures that,

in the past, have promoted unwise growth and development on previously undeveloped barriers.

As in the case of undeveloped barriers, scientific and planning research must precede changes in governing policies and regulations. Baseline data need to be collected to better understand the specific flood hazard vulnerability, erosion trends and migration rate of a particular developed barrier and should address the following four factors: (1) onshore sediment movement; (2) storm activity; (3) equilibrium readjustment to sea level rise; and, (4) construction activities along these shores (Fisher, 1977).

Developed and highly urbanized barriers no longer have the natural environmental characteristics they once had in the undeveloped state. Instead, a large financial investment and population center has been substituted. However, the hazard vulnerability of the barrier still remains and actually may increase with expanded growth and development. Based on the scientific understanding of a particular barrier, planning studies can be used to formulate a set of site specific recommendations for reducing or mitigating future storm damages. It is then up to government officials to select and implement the appropriate recommended mitigation activities.

OCEAN CITY: AN URBANIZED COASTAL BARRIER

GROWTH AND DEVELOPMENT

Northward progression of commercial and residential development from the south end of Fenwick Island to the Delaware state line has occurred since 1872 (see Figure 2). Since that time, the small resort community of Sinepuxent Beach has become a major east coast recreational center of Ocean City, Maryland.

In 1878 the railroad provided the first established means of transportation to Fenwick Island. Today almost all transportation is by automobile. The opening of the Cheasapeake Bay Bridge in 1952 connecting Sandy Point (on the western shore) with Kent Island (on the Maryland eastern shore) was probably the most significant factor affecting Ocean City's growth (Dolan et al, 1980). This bridge reduced the travel time to Ocean City from Baltimore and Washington, D.C. to 2.5 hours. Three highways provide for easy access to Ocean City; U.S. Routes 50 and Maryland Route 90 cross (east to west) over Isle of Wight and Assawoman Bays and the Coastal Highway (Maryland Route 528) extends north into Delaware.

Other infrastructure which has promoted growth and development of Ocean City include water and sewer facilities. The Manokin Aquifer, 33 feet thick and at a depth of 372 feet, is the source of groundwater for Ocean City and other towns in the area (U.S. Army Corps of Engineers [COE], 1980). The potential groundwater supply was estimated to be several times the 1973 capacity assuring a continued growth rate for some time to come (Slaughter, 1973).

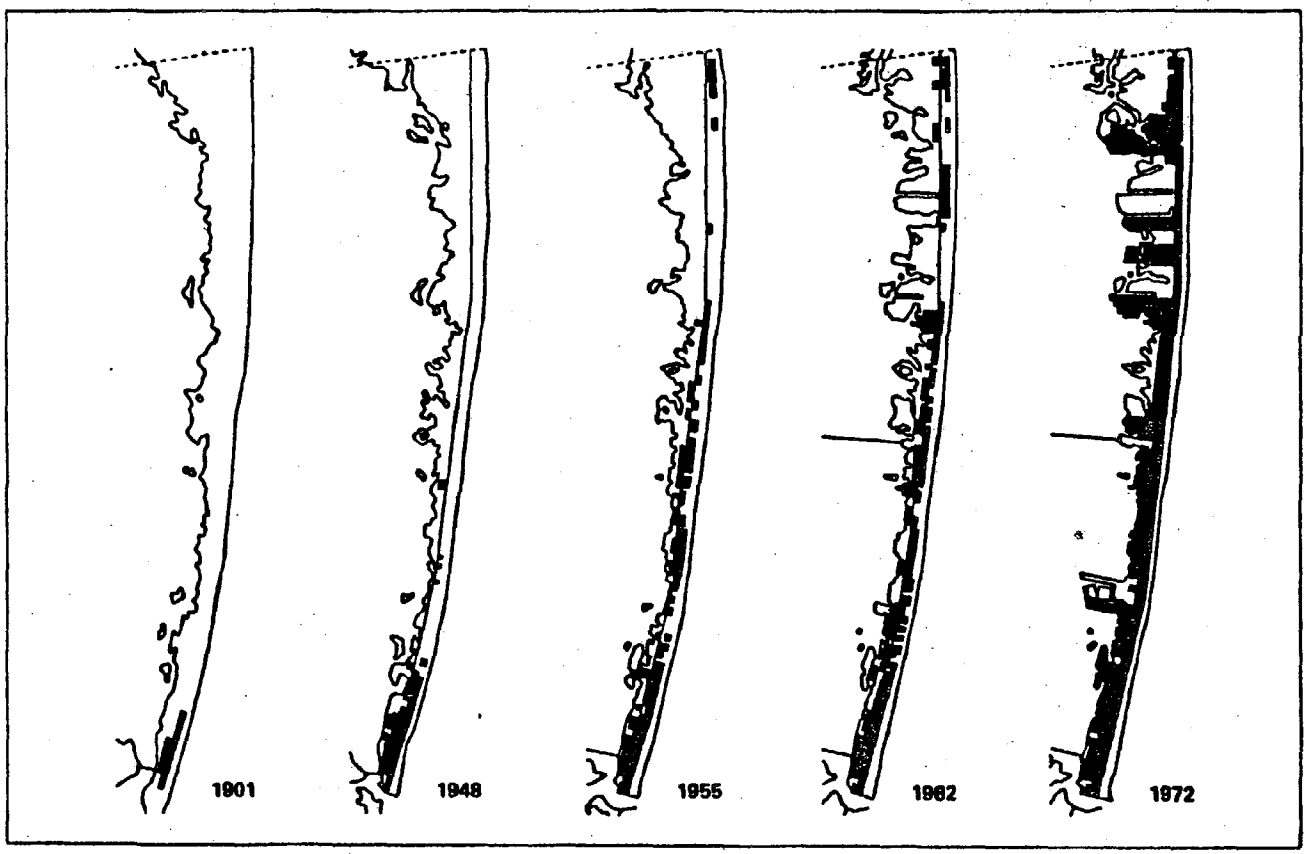


Figure 2. **Northward progression of development between 1901 and 1972.** *(Source: Dolan et al., 1980).*

When Ocean City began its rapid growth in the late 1960's, sewerage facilities became necessary, and the Ocean City Treatment Facility was completed in 1968 to provide primary treatment of 4 million gallons per day. After expansions of the facility, a capacity of 12.4 million gallons per day with secondary treatment has been provided since 1981. A North Ocean City Interceptor Sewage Pipeline is currently under construction which will provide capacity to accommodate additional growth in this part of the City.

The close proximity of Ocean City to major metropolitan areas, the excellent access to the City, and the availability of adequate water and sewerage facilities have resulted in the rapid growth of Ocean City as a tourist resort. Although the permanent population was estimated in 1982 to be only about 5,700, over 250,000 people are estimated to be in the Ocean City during peak summer weekends. Mid-1970 statistics show the existence of 26,663 housing units of which over 75% were hotels, apartments and condominiums.

This large concentration of people and property occupies a coastal barrier, and they are vulnerable to the impacts of coastal storms and floods, particularly in late spring and late summer. The development also has an effect on the natural protective features provided by the barrier.

THE FENWICK ISLAND SYSTEM

The barrier beach which Ocean City occupies still provides a storm damage prevention and flood control function which affects other barrier and mainland environments in spite of its developed status. This nine mile long, five to 25 foot high landform which averages 1/2 mile in width divides the Atlantic Ocean from Assawoman and Isle of Wight Bays taking the brunt of storm waves and tides, and thus protecting inland

areas. The point of attachment for Fenwick Island lies within the State of Delaware to the north. During parts of the year, the southern coast of Delaware is benefitted by longshore sediment being transported north from Fenwick Island. To the south, the island terminates at the Ocean City Inlet which separates it from Assateaque Island. The downdrift offset relationship between these two barriers has been well documented (Leatherman, 1979) and is briefly described in this report.

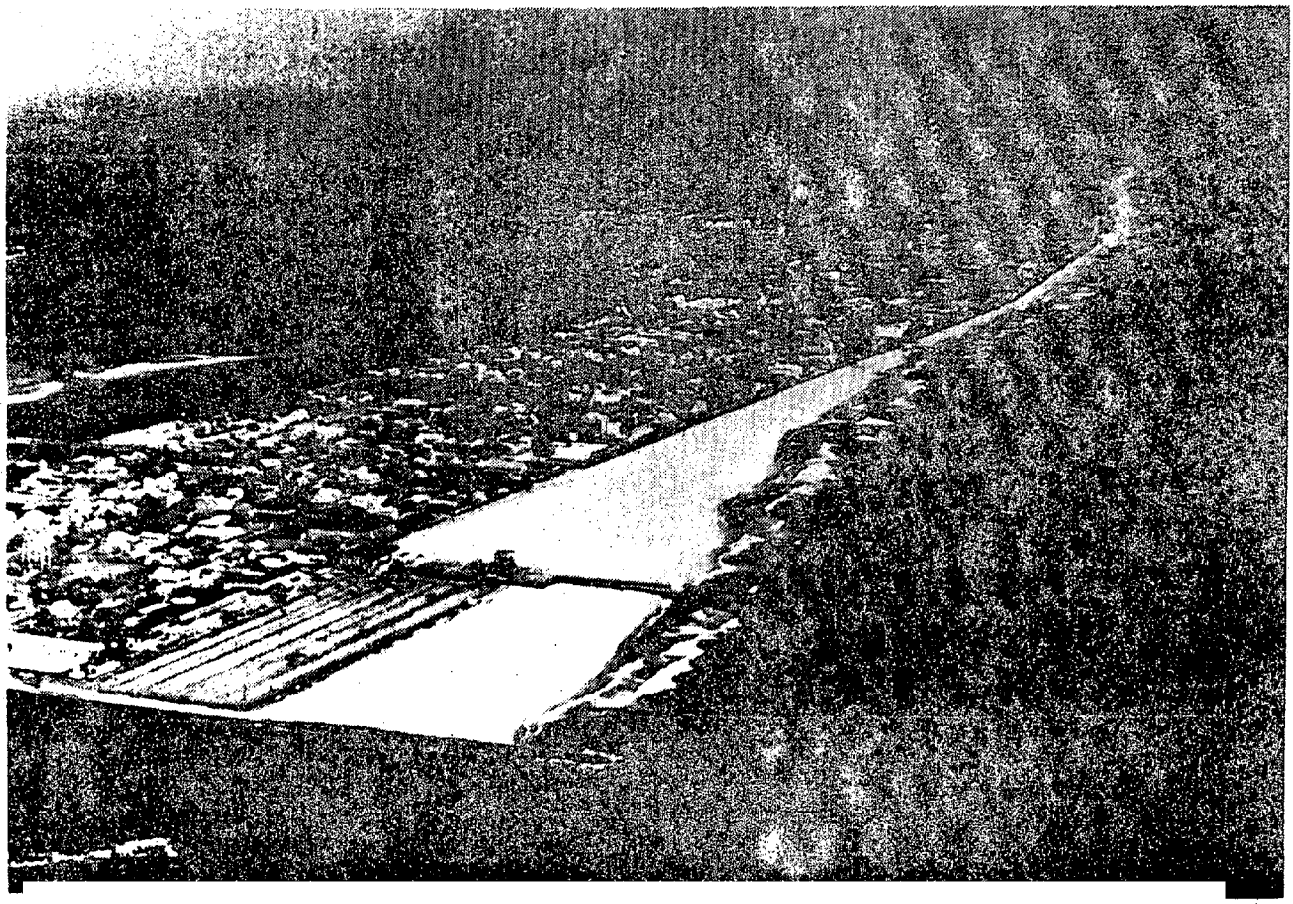
The mainland of Worcester County directly west of Fenwick Island and separated from the island by Isle of Wight and Assawoman Bays, greatly benefits from the natural functions of the barrier island: bay tidal ranges are reduced from 3.4 feet to 2.2 feet (NOAA, 1983), fetch distances are limited and the topography of Fenwick Island, although quite low, absorbs a major part of coastal wave and current damages. Because of this relationship, the 100-year floodplain of Worcester County directly west of Ocean City will be addressed as a hazard prone environment in the Ocean City area.

Although Fenwick Island is no longer an undeveloped barrier in its natural state, this somewhat stabilized island is still characterized by low-lying, hazard prone areas subject to both gradual and sudden changes as evidenced by its storm history. Within a relatively short distance perpendicular to shore, the geomorphic characteristics and hydrodynamic processes of Fenwick Island change rapidly. Hypothetically during a major storm event, deep water waves exceeding 30 feet in height will travel landward over a wide, flat nearshore zone, diminish to a size about 0.55 times the depth of water, break on a steep beach, run up the face of any dune or other elevated obstruction and overwash onto higher ground with the possibility of joining the bay waters. Due to the somewhat stabilized nature on the islands onshore area, its offshore profile has steepened increasing the potential for damage from future storms.

Three moderate to major storms in 1902, 1933 and 1962 have occurred in Ocean City, thus, inflicting significant damage to Ocean City about every 30 years. In August 1933, a hurricane was responsible for the formation of Ocean City Inlet. On March 6-8, 1962, a northeast storm left an estimated damage of $11.3 million in 1980 dollars (COE, 1980). The hurricanes that occurred in 1938 and 1944 and northeasters that occurred in 1960 and 1978 were considered to be minor storms (COE, 1980). Study of the high frequency, minor storms (i.e., the 10-year event), moderate frequency storms (i.e., the 50-year event) and low frequency, major storms (i.e., the 100-year event) is important for the identification of vulnerability of the area to the hazard of erosion, floods or a combination of the two. For this study, wind processes are not considered directly, but such related hazards should not be overlooked by officials, particularly with respect to hurricanes.

The following section details each of the major hazard areas of the barrier island that collectively define the overall hazard vulnerability of Ocean City.

FLOOD HAZARD VULNERABILITY



HAZARD PRONE AREAS

Hazard planning for barrier island resorts such as Ocean City, Maryland, often fail to fully recognize the impact of natural geologic and geomorphic processes on the built environment and island users. To summarize and assess the available data on the natural and built environments for Fenwick Island, five subenvironments were selected on the basis of their geomorphic characteristics and hazard vulnerability: (1) the nearshore zone; (2) the shore zone; (3) the high hazard zone; (4) the 100-year floodplain; and, (5) Isle of Wight and Assawoman Bays (see Figure 3). The compilation of existing data and information will provide a characterization of existing hazard prone areas, serve as a basis for selecting areas of greatest risk and contribute to the evaluation of existing erosion and flood control plans.
A specific study of beach dynamics which might include beach profiling and littoral environmental observations similar to that conducted in Avalon, New Jersey (Farrell and Stinton, 1983) was not undertaken.

The primary cause of coastal floods for the Ocean City area is the occurrence of hurricanes and northeasters. Both storm types generate winds and waves across the Atlantic Ocean that impact the shoreline and inland areas. Hurricanes have very high winds (74 mph or greater) and can generate large waves capable of massive destruction. They approach and pass through an area rapidly, usually affecting a relatively small portion of a shoreline. Their duration is usually one tidal cycle (less than 12 hours) and wave approach is from the southeast. The period of greatest hurricane threat extends from August through October. In contrast, northeasters are characterized by lower wind speeds and smaller wave heights, but they can reside offshore for extended periods of time (up to three days or six tidal cycles) and affect a wider geographic area. Northeasters normally occur during the winter months.

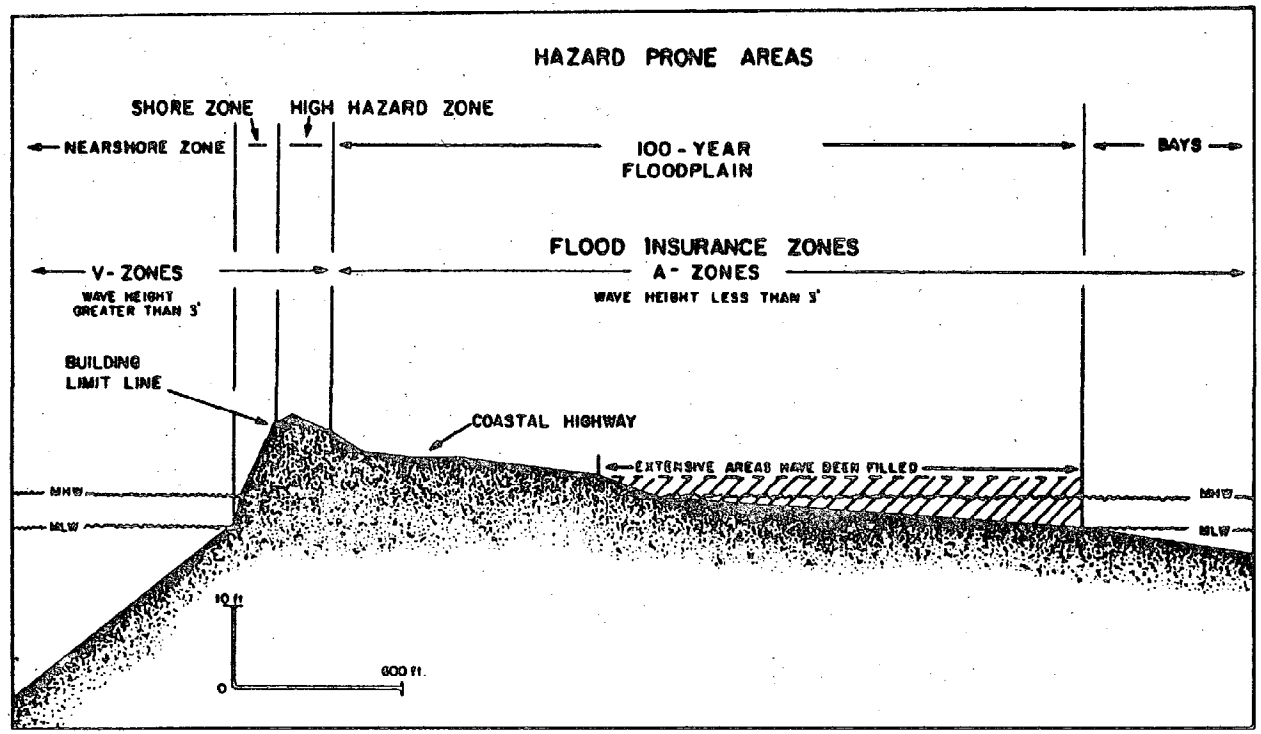


Figure 3. Typical cross-section of the barrier beach (Fenwick Island) at Ocean City, Maryland showing five selected hazard prone areas in reference to the flood insurance zones and several cultural features.

Throughout this section, several datums are referenced which, unless briefly defined, can offer some confusion. The mean tidal range for Ocean City on the Atlantic Ocean side is 3.4 feet. The zero elevation used in Ocean City is Mean Low Water (MLW); therefore, Mean High Water (MHW) is 3.4 feet. The zero elevation for Ocean City converted to the National Geodectic Vertical Datum (NGVD) equals -1.2 feet; therefore, MHW is 2.2 feet NGVD. Because FEMA and the Corps of Engineers use NGVD, city engineers, insurance agents and the general public in the Ocean City Area must add at least one foot to any elevations given by federal agencies if they normally use the City datum of MLW.

THE NEARSHORE ZONE

This zone is located seaward of MLW by standard classifications (COE, 1977) and includes the offshore area. Knowledge of historical changes in the offshore slope provides an understanding of the impacts which result from barrier island stabilization and the resultant increase in hazard vulnerability of the island. In addition, the configuration of the offshore bathymetry has a direct influence on the process of wave refraction or concentration of erosion zones on shore.

Offshore Bathymetry

A significant trend emerges from historical bathymetric data of the waters offshore of Ocean City. The Corps of Engineers bathymetric profiles (confirmed by comparison with original Coast and Geodetic Survey sheets) clearly indicate that the shoreface has been steepening through time. The landward movement of the 20-foot depth contour has been greater than the 10-foot depth contour, which in turn has migrated further than the mean high water contour (see Table 1).

Table 1. Contour Shifts from 1929-1965 *(Trident Engineering 1979)*

	Over 36 Year Period	Average Per Year
MHW contour	86 feet	2.4 feet
-10 foot contour	252 feet	7.0 feet
-20 foot contour	350 feet	9.7 feet

It appears that the shoreline has remained in approximately the same location and is acting as a hinge as the adjacent shoreface steepens. Although it is not known what angle of shoreface inclination is the natural equilibrium position, the current steepened condition cannot be considered at equilibrium since recent bathymetric data have shown that the steepening trend has continued.

According to a geologic principle that most geomorphic change occurs in quantum steps, a major coastal storm would provide the impetus for a decrease in the angle of inclination by shifting and redistributing nearshore sands in a landward direction to reverse the steepening trend of the shoreface. Thus, major shoreline recession will occur and the shoreface inclination will return to its minimum angle. Over time, the shoreface will continue to again slowly steepen until the next major storm.

Applying this principle to Ocean City, Maryland, steepening of the offshore profile has probably continued since the last major storm in 1962. A quantum step in beach recession will occur during the next

major storm in order for a lower equilibrium slope to be reestablished. However, the static shoreline position now held by the City will mean that (1) a steep slope will still remain and (2) the impact of lesser storms may be just as great as that which occurred in previous major storms.

Wave Refraction and Sand Movement

Wave refraction analysis for Maryland and Virginia (Goldsmith et. al., 1975) predicts areas of wave concentration along the coastline for various storm conditions. As reported by the Corps of Engineers (1980), offshore dredging can also alter the characteristics of the incoming storm waves, perhaps causing abnormal concentrations of wave energies along certain stretches of the coastline.

The wave refraction data indicate wave concentration in the northernmost portion of the study area, near the Maryland-Delaware line, and also a secondary concentration at the Ocean City Inlet area. These data are not clearly reflected by the shoreline recession information, possibly because of the pulsaic nature of barrier island retreat and downdrift migration of low amplitude, very long period sand waves. In less technical terms, the shoreline configuration in Ocean City is modified in a similar manner along the nine mile stretch of beach with no one area experiencing more erosion than another over the long term because of wave refraction. Sand moves alongshore as well as onshore and offshore in this zone. The gross rates of sand movement are estimated to be about 450,000 cu.yds. per year northerly, and 600,000 cu.yds. per year southerly, resulting in a net drift of 150,000 cu.yds. per year to the south (COE, 1980).

THE SHORE ZONE

For purposes of this discussion, the shore zone is located between the nearshore zone and the approximate seaward extent of development (the State-Ocean City Building Limit Line) and includes the beach and berm areas.

Historical shoreline changes, natural beach characteristics and the presence of shoreline protection structures are primary indicators of shore zone hazard vulnerability. The shore zone is the area of first defense against damages primarily caused by erosion, but as elevation is considered, flood control becomes an equally important issue.

Historical Shoreline Changes

National Ocean Survey (NOS) quantitative shoreline change data since 1849/50 were used to analyze historical shoreline erosion. Automated techniques of processing the data and plotting maps from these historical sources, specifically using stereoplotters and metric mapping techniques, can be used to obtain highly accurate information concerning historical shoreline movement trends (Leatherman, 1983). For Ocean City, a computerized procedure was developed by which transects were drawn across the barrier at predetermined distances along the island and shoreline changes between certain time periods for these locations determined. Forty-two transects 1000 feet apart were used to determine shoreline changes from the period 1850-1980; 1850-1908; 1908-1929; 1929-1980; 1929-1942; 1942-1962; and 1962-1980.

Over 50 years of data between 1929 and 1980 (see Figure 4) indicate erosion was mostly concentrated north of 57th street. More specifically, an average erosion rate of 2.7 feet per year existed north of 21st Street and an average accretion rate of seven feet existed south to the inlet. The actual rate of accretion may have been slightly

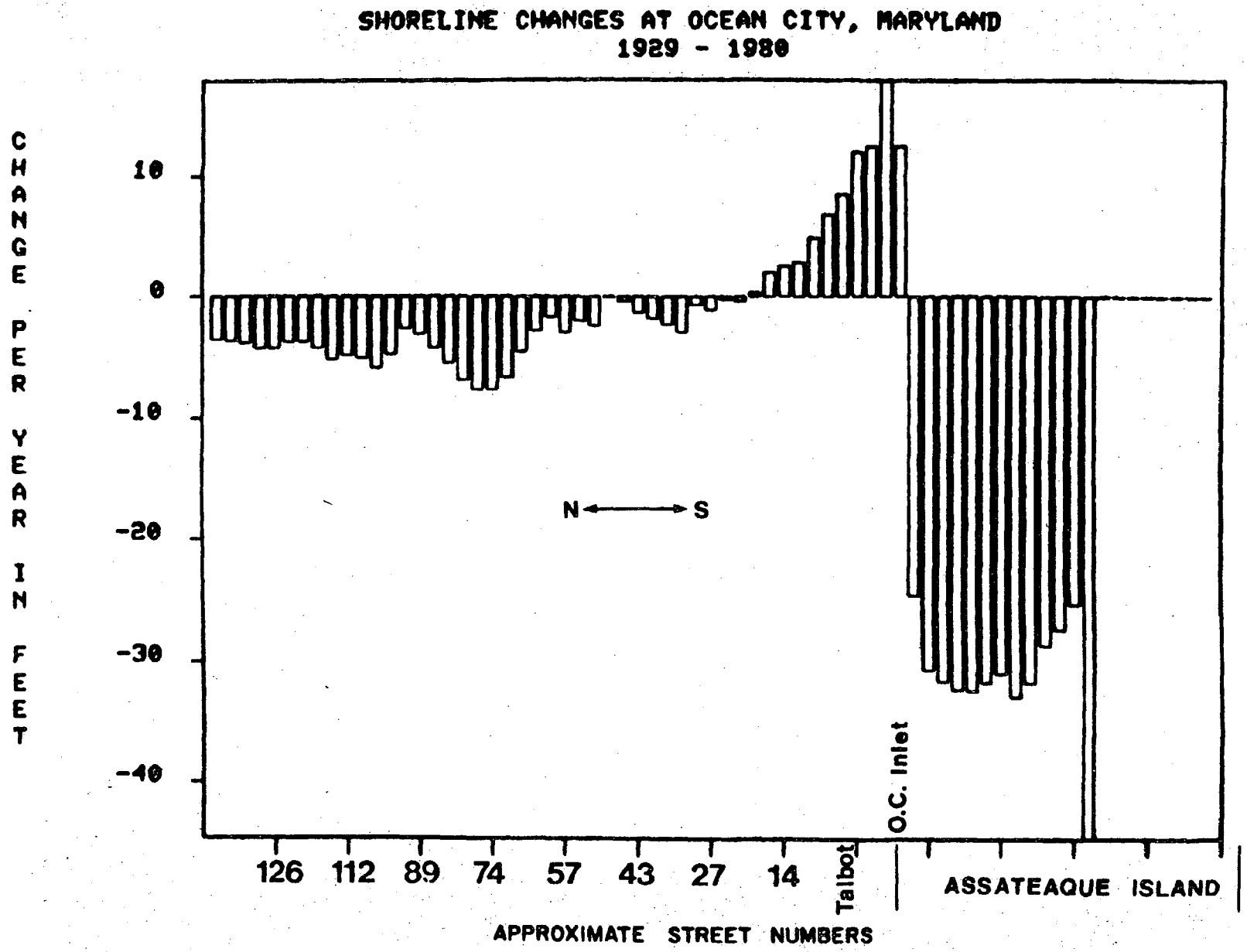


Figure 4. Shoreline change rates between 1929 and 1980.

higher because most of it occurred during a shorter time period (1929-1962). This 50 year period is important since the major changes occurring during this time period include the effects of the 1933 hurricane, the construction of the north jetty in 1933, the construction of 50 groins, the March 1962 storm, post-storm beach and dune reconstruction and a major increase in oceanfront development.

About 130 years of data between 1850 and 1980 (see Figure 5) indicate the longer term average erosion rate north of 27th street is only 1.7 feet per year. Erosion was mostly concentrated between 5th and 89th streets. A comparison of the two periods (1850 to 1980 and 1929 to 1980) indicates beach erosion in Ocean City is occurring at a faster rate on a short-term basis and is more problematic in the central and northern portions of the barrier.

As noted above, several major changes have recently occurred which may explain the higher erosion rates. Within the period from 1929 to 1980, erosion rates of 11.4 feet per year (1929-1942), 0.3 feet per year (1942-1962) and 1.2 feet per year (1962-1980) occurred. The impacts of the 1933 hurricane probably account for the high rate between 1929 and 1942. Subsequently, a period of relative stability followed between 1942 and 1962. During the most recent period (1962-1980), the March 1962 storm occurred, but its erosional impact was offset by an emergency beach and dune restoration effort and perhaps the newly constructed groins.

Beach Characteristics

The area between MHW and existing development is an important indicator of hazard vulnerability because the storm waves and flood-related erosion focused here place oceanfront development in immediate danger. Height and width of this upper beach area indicate the level of protection that is naturally provided. Using a 1981 Photogrammetric

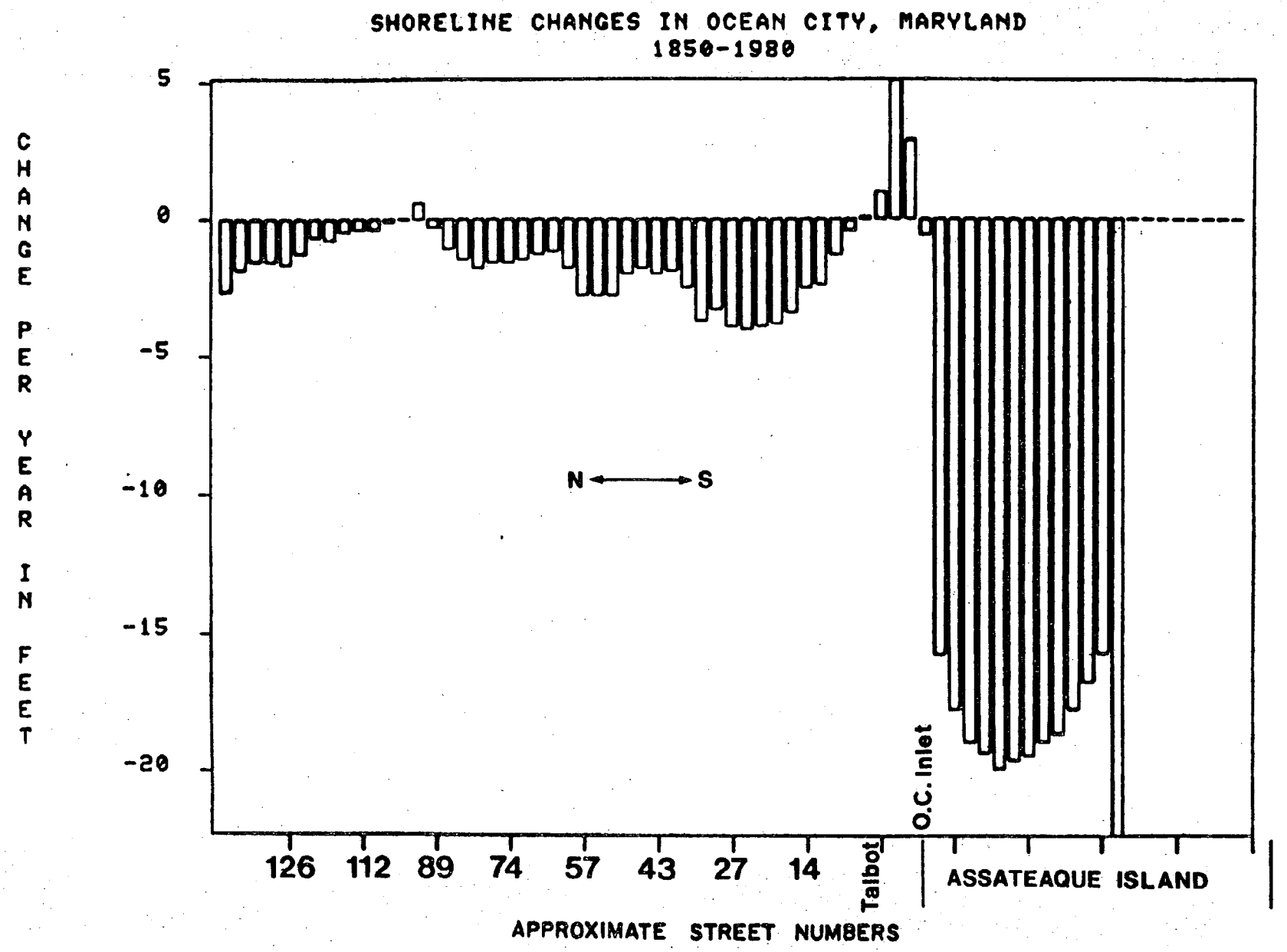


Figure 5. Shoreline change rates between 1850 and 1980.

Survey of the Beach Control district, linear measurements between MHW and the Building Limit Line (BLL) were taken at 150 street locations from Ocean City Inlet to the Maryland-Delaware line and plotted (see Figure 6). The average distance from MHW to the BLL is 135 feet; the average height above MHW at the BLL is 9.7 feet (11.9 NGVD); and, the average slope is 7.2% or 1:14. North of 50th Street, an equilibrium slope appears to exist established. Generally, the wider the beach is between the MHW and BLL, the higher the BLL is in elevation. Conversely, the narrower the beach is, the lower the BLL.

The least amount of erosion and flood control protection, as a function of beach width and height exists between 73rd and 91st Streets, and between 119th and 132nd Streets, approximately. The greatest protection north of 7th Street exists between 50th and 60th Streets and between 92nd and 118th Streets, approximately. South of 7th Street, where beach widths are greater than 200 feet because of accretion extending up the beach from the North Jetty development is provided the most protection.

Using the average elevation of the beach at the Building Limit Line (9.7 feet MHW) and assuming four feet of erosion would occur during a storm (as assumed during the most recent Flood Insurance Study, 1983), the resultant 5.7 foot elevation would be exposed to waves during a very minor event. Using the Corps of Engineers storm frequency distribution curve (COE, 1980; Figure D-16), the current level of beach protection afforded in Ocean City is the 2-year frequency storm event. Given the possibility of error at the lowest end of the distribution curve, it would be more accurate to state that less than 5-year storm protection exists.

Shoreline Protection Structures

Development in the shore zone is limited to coastal engineering structures, including the North Jetty, a timber pile pier and 52 timber

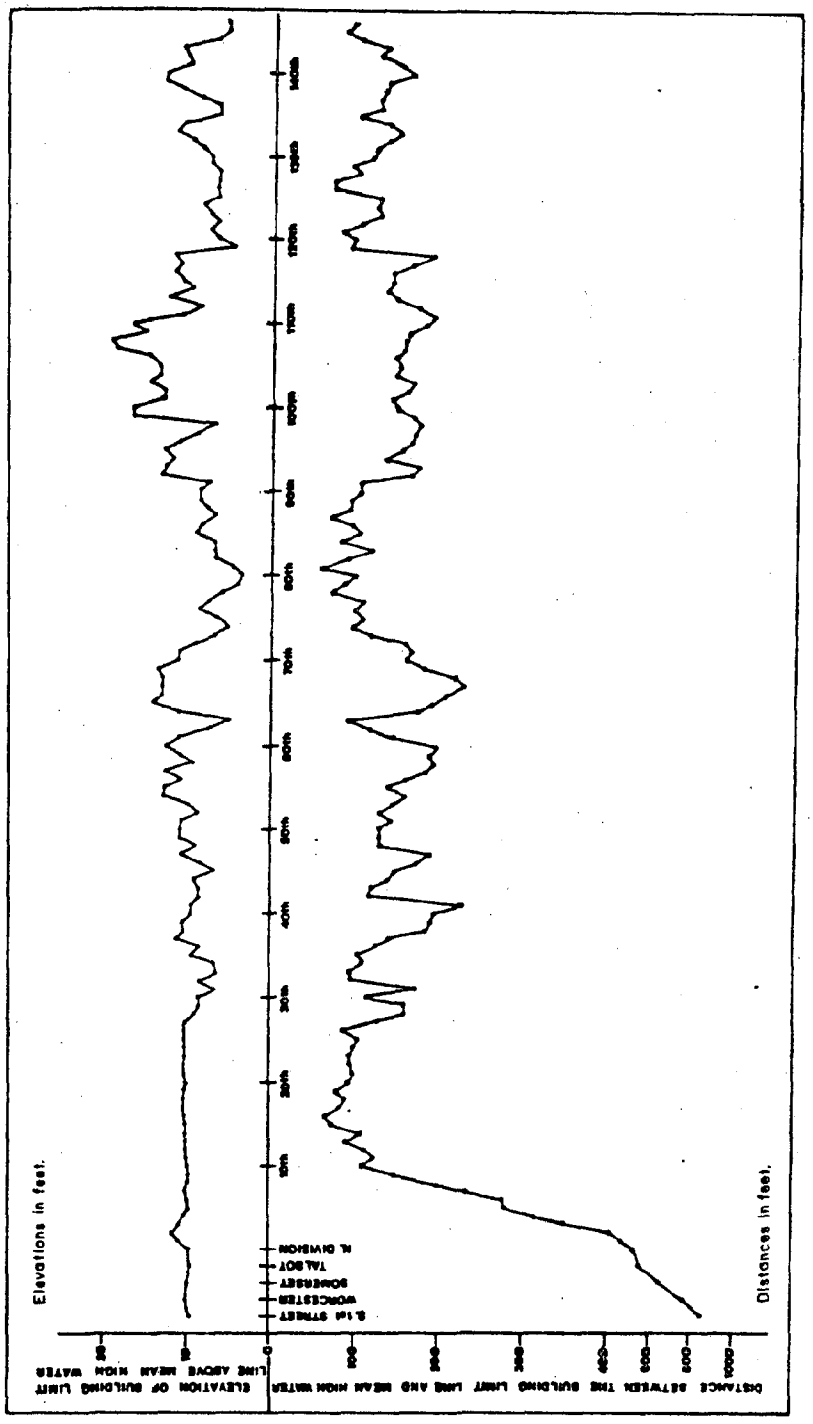


Figure 6. Distance and elevation measurements within the area between mean high water and the Building Limit Line (1981).

and stone groins (see Table 2). The impact of the North Jetty is obvious. Approximately 150,000 cu.yds. of sand have been trapped and have covered 11 groins rendering them ineffective.

The impact of the remaining groins is less obvious. Using the May 1981 photogrammetric survey maps, a quantitative analysis at each groin revealed that no definitive trend exists regarding updrift accretion and downdrift erosion. The differences in position of MLW north and south of each groin at a distance equal to the length of each groin averaged about 25 feet. Beach slopes (MLW to MHW) near the groins were approximately 9.7% or 1:10. Since the average slope is 7.2% or 1:14, beaches near groins are steeper and less stable.

THE HIGH HAZARD ZONE

The high hazard zone is considered for this discussion to extend from the BLL landward to the western edge of the V-zone (the area affected by waves greater the three feet high during the 100-year storm) as delineated on the 1983 Flood Insurance Rate Map (FIRM). This zone extends from 27th Street north to the Delaware line (about seven miles), varies between 70 and 310 feet wide and averages about 190 feet wide. Existing and future development within this area is the most vulnerable to flood damages during a 100-year flood because it is exposed to the direct effects of waves and high velocity water. Appendix A contains maps show the relationship between the location of existing structures and that of the V-Zone.

Predicted Storm Elevations

For the most part, dunes and open space which once acted to buffer the effects of storm waves, currents and overwash have now been replaced with single family residences, high rise condominiums, motels and parking lots. The most recent FIRM, effective May 16, 1983, predicts

Table 2. Inventory of Existing Groins

(adapted from Trident Engineering, 1979).

Location	Year Completed[1]	Type[2]	Exposed[3] Length	Groin[4] Work	Spacing[5]
Between S. Division and S. 1st Streets	1922-24		0	-	
Worcester Street	1922-24		0	-	
Somerset Street	1931		0	-	
Talbot Street	1928		0	-	
N. Division Street	1931		0	-	
N. 1st Street	1930		0	-	
2nd Street	1931		0	-	
Between 3rd and 4th Streets	1932		0	-	
Between 4th and 5th Streets	1931		0	-	
Between 5th and 6th Streets	1932		0	-	
Between 6th and 7th Streets	1932		0	-	
8th Street	1932	T	20·	-	400·
9th Street	1934	T	30·	-	400·
Between 10th and 11th Streets	1934	T	70·	-	500·
12th Street	1938	T/S	100·	-	370·
13th Street	1962	T/S	90·	-	370·
14th Street	1930			-	
- repaired	1973	T	100·	DNR	400·
15th Street	1933,1960	T		-	
- extension	1978	S	170·	DNR	450·
16th Street	1938	T/S	140·	-	520·
18th Street	1949	T	140·	-	490·
Between 19th and 20th Streets	1962	T	140·	-	480·
21st Street	1951	S	150·	-	320·
22nd Street	1962	T	90·	-	450·
23rd Street	1951	T	100·	-	600·
- repaired outboard end	1978			DNR	
25th Street	1974	T	110·	DNR	370·
26th Street	1951	T	120·	-	1020
29th Street	1973	S	170·	DNR	650
31st Street	1975	T	140·	DNR	1100
- revision	1978			DNR	
34th Street	1978	T	240	DNR	2100
41st Street		S	220		1800
47th Street		S	200		1200
51st Street	1978	T	20	DNR	2100
58th Street	1978	T	100·	DNR	650
60th Street		S	120·		3300
71st Street	1975	T/S	100·	DNR	600·
73rd Street	1961	T	180	-	450·
Between 74th and 75th Streets	1961	T	180	-	450·
76th Street	1961	T	130·	-	300·
77th Street	1974	T/S	180·	DNR	900
80th Street		S	230·	DNR	900
83rd Street		S	180·		780
86th Street	1975	T	170·	DNR	750
89th Street	1975	T	190	DNR	450·
91st Street	1973	T	150	DNR	600·
93rd Street		S	150·		1140
98th Street		S	150·		800
102nd Street	1975	T	140	DNR	1800
112th Street		S	190·		1670
118th Street		S	180·		2550
125th Street		S	120·		1100
128th Street	1975	T/S	100·	DNR	750
130th Street	1978	T	60·	DNR	

[1] Where no date is entered, it is presumed completion occurred between May 14, 1979 and May 3, 1981.

[2] S = Stone; T = Timber

[3] Length in feet.
(·) indicates totally exposed surface; otherwise, there is intermittent exposure.
standard Ocean City groins between South 1st Street and 130th Street are approximately 200 ft in length.

[4] DNR indicates work done by Maryland Department of Natural Resources.
(-) indicates work done by "others" (presumably Department of Transportation).
no entry indicates unknown work responsibility.

[5] Distance to next (higher street number) groin in feet.
(-) indicates spacing meets Corps of Engineer standards.

100-year frequency storm surge elevations with waves to reach 11 feet NGVD within this developed area. This estimate is two feet above the previous FIRM predictions which did not include wave heights. The methodology employed in the revised FIRM assumed four feet of shoreline erosion would occur seaward of all development north of 15th Street. Six transects were used to determine the landward boundary of the V-zone. They were located at approximately 6th, 20th, 44th, 81st, Purnell and Franford Streets.

In addition to the 100-year storm predictions, consideration of flood elevations for the 10- and 50-year frequency storm events is also important for a better understanding of the overall flood hazard vulnerability. Using storm frequency data from the Corps of Engineers (COE, 1980) and Flood Insurance Studies (FIS, 1983), the 10-year and 50-year flood elevations for the V-zone were derived (see Table 3). Based on the FIS 100-year elevations, the difference between the stillwater level (8.1 feet) and the V-zone elevation (11.0 feet) is 2.9 feet. This differential was used to obtain values for the 10- and 50-year V-zones. The stillwater elevations from the Corps of Engineers are 0.6 feet higher than those in the FIS. The Corps value is considered more conservative in that it represents a higher level of hazard. Using the Corps data, a summary of the estimated 10-year, 50-year and 100-year storm elevations based on a MLW datum are shown in Table 4. This summary information provides an easier means of evaluating other maps and charts that use different datums and should be used in specific building requirements.

By comparing the V-zone elevations with the BLL elevations, analysis of hazard vulnerability during the 10-year, 50-year and 100-year storm events was made for the high hazard zone north of 27th Street. Since beach erosion is related to storm intensity and duration and is, therefore, somewhat independent of the storm frequency event, a four

Table 3. Comparison of the 10-year and 100-year Ocean Storm Elevations (NGVD in feet)

	STILLWATER	V-ZONE
100-year	8.7/8.1[1]	12/11
50-year	8.0/7.4	11/10
10-year	6.4/5.8	9/9

[1]Corps of Engineers (COE)/Flood Insurance Study (FIS)

Table 4. Summary of the Estimated 10-year and 100-year Ocean Storm Elevations (MLW in feet)

	STILLWATER	V-ZONE
100-year	9.9	13.2
50-year	9.2	12.2
10-year	7.6	10.2

foot erosion value is assumed as it was in the 1983 FIS. In terms of which oceanfront areas can be expected to receive flood induced erosion, 75%, 90% and 92% of the shoreline north of 27th Street is vulnerable to the 10-year, 50-year and 100-year events, respectively. Variations in beach width are an important factor which would control wave processes and impact. Qualitatively, the wider the beach is, the more seaward waves will break and the less impact there will be at a certain elevation. A qualitative analysis of beach height and width was presented in the previous section.

Flood elevations were delineated on the FIRMs according to existing upland topography without considering differential vulnerabilities to flooding and erosion except at the six transects. Several of the factors one must consider in defining differential vulnerabilities include man-made and natural obstructions such as seawalls and dunes, other human modifications such as buildings and pavement and the extent of natural vegetation. Nonetheless, the 1983 FIRMs represent the most accurate hazard mapping product avaialable.

Impact of Development

Human modification in the high hazard zone has had a profound effect on the storm susceptibility of Fenwick Island. The built environment affects the barrier's ability to respond naturally to storm conditions in many ways. Among these are: 1) interference with aeolian (wind) and overwash transport processes through paving and other construction; 2) removal of the natural dune line which increases back barrier susceptibility to storm waves; and, 3) construction of tall buildings and seawalls which can force highly erosive currents through gaps between the structures.

On a barrier island that is in its natural state, sand is often transported from the beach to the barrier flats during storms. This

transport occurs by both aeolian and overwash processes. During periods of quiescence following storms, some of this sand is transported back to the beach by the wind. This aids in natural beach restoration and dune formation. Areas having the vegetation to trap sand, like that found on Assateague Island, are exceptions on Fenwick Island.

Human intervention by development of barrier islands, such as Ocean City, have diminished the effectiveness of this process. Sand is prevented from moving to the back dune areas in storms by the tall buildings and other structures which block and funnel the wind and water. These buildings may also diminish the occurrence of overwash, but more likely, will actually concentrate the flow into discrete areas between the buildings. Following a coastal storm, the recent practice in Ocean City has been to use bulldozers and snowplows to remove beach sand that has accumulated on streets and parking lots, and dump the sand on unused land, into the bay, or push it onto the beach. It is difficult to evaluate the short-term ramifications of this interference with the natural migration processes of a barrier beach, but clearly the barrier surface has not been allowed to build vertically, as would occur in a natural setting with sea level continuing to rise.

An inventory of man-made obstructions located in the high hazard zone included the identification of the number and extent of seawalls (as shown on the 1981 Photogrammetric Survey), and the number of structures (as shown on the 1981 Photogrammetric Survey and May 1983 aerial oblique photos). A total of 18 seawalls were identified as having a cumulative length of 3,690 feet or 10% of the shoreline between 27th Street and the Maryland-Delaware line (see Figure 7). A count of 336 residential and commercial structures was made without a distinction of size, and any portion of a structure in the V-zone was regarded as a total structure. Sixteen new structures were identified as completed or under construction since 1981. Eighteen buildings are over 10 stories high

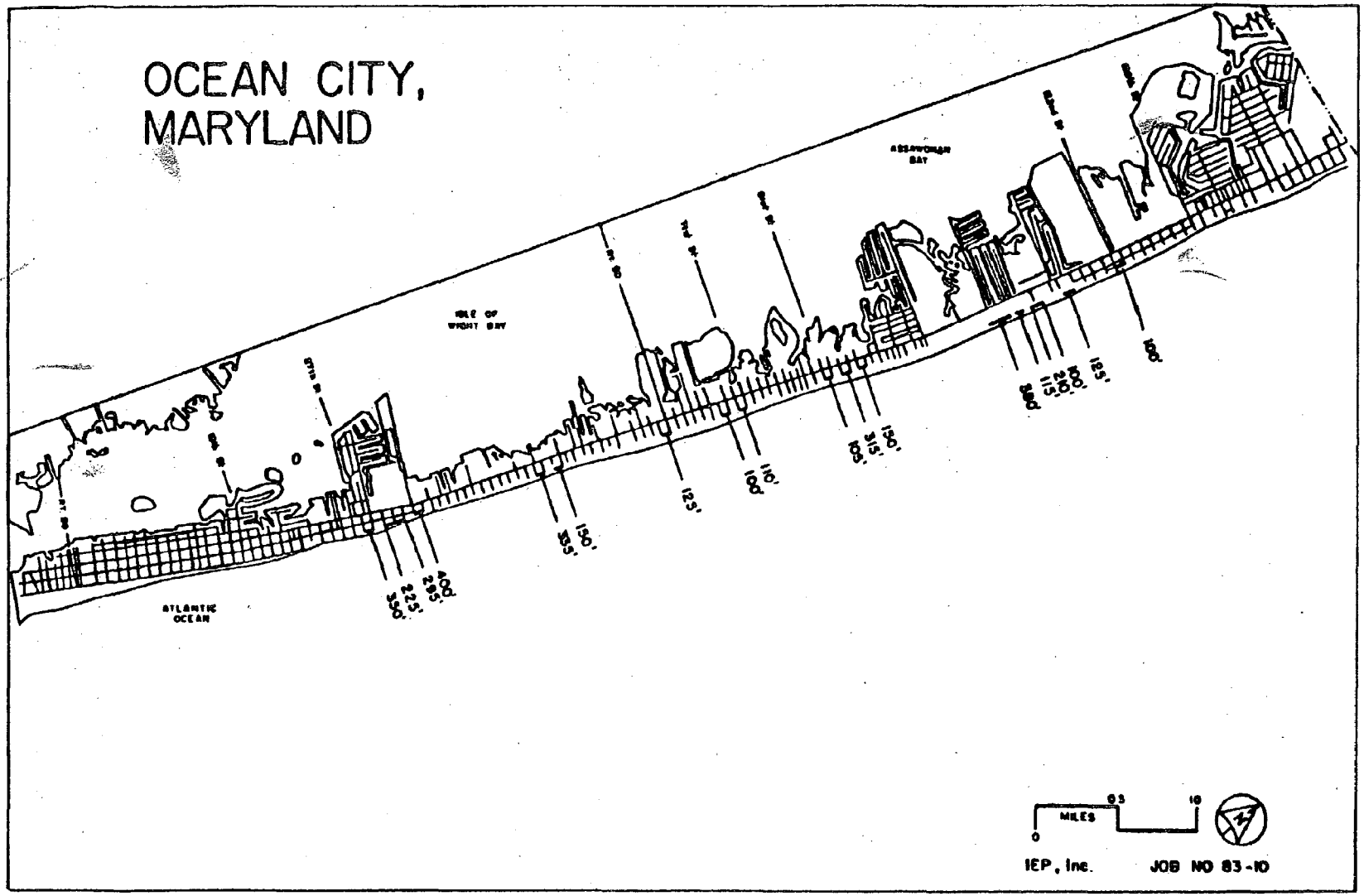


Figure 7. Location and length (in feet) of existing seawalls.

and only eight of the 119 blocks inventoried are currently vacant in the V-zone. The areas previously identified as having the least amount of erosion and flood control protection seaward of the BLL are occupied by 119 structures in the V-zone. The areas previously identified as having a greater amount of protection have 71 structures associated with them. One reason for a lower number of structures in such areas is that many high rise condominiums are located in these areas. Reduced copies of the 1981 Photogrammetric Survey are contained in Appendix A showing the Flood Insurance Zones in relation to the existing development.

The present position of the shoreline is rapidly becoming determined more by the extent of development and encroachment toward the Building Limit Line than the natural process of erosion, at least for this current period of low storm activity. If more seawalls and bulkheads are constructed, their effect on beach erosion and storm overwash will predominate over natural processes and make any prediction of the most hazard prone areas more difficult.

THE 100-YEAR FLOODPLAIN IN FENWICK ISLAND

According to the recent FIRM, the entire city north of 27th Street for all practical purposes is within an area which will be inundated by water associated with the 100-year flood. Two isolated areas located along the Coastal Highway between 63rd and 67th Streets and between 119th and 124th Streets are slightly higher in elevation and are designated as 500-year floodplains. A two block wide area between the inlet and 27th Street also has this designation. Even within the areas designated as a 500-year floodplain (B-zone) shallow flooding less than one foot may occur.

Predicted Storm Elevations

Flood elevations of the 100-year storm (A-zone) decrease west of the V-zone toward the bay from nine feet to six feet respectively. This updated information broadly contrasts with information presented in the 1976 FIRM. In the 1976 FIRM, most of the area east of the Coastal Highway was designated as the 500-year floodplain and remaining areas to the west had 100-year flood elevations of nine feet. Two primary reasons are responsible for the higher beachfront elevations and lower bay elevations: 1) wave heights were incorporated on the storm surge, and 2) lower tidal ranges were recognized in the upper reaches of Assawoman Bay.

It should be understood, however, that the information provided by the FIRM was obtained by using a methodology that is used in coastal areas for the purposes of defining hazard prone areas and properly rating structures for insurance purposes. Again only six transects were used along the nine mile stretch of Ocean City, and the information was interpolated between these transects in order to produce a hazard map for the city. The FIRM also didn't consider the hazard potential of an ebb surge flowing back over Fenwick Island as a storm passes from the area.

Historical Overwash

Historical data from the March 1962 storm is particularly helpful in defining the type of hazard to which a majority of the island is exposed. Accounts in the newspapers and Corps of Engineers reports note the deposition of up to six feet of sand on the streets. Flood currents were strong enough to move sand across the entire island in certain locations (see Figure 8). For proper perspective, it must be emphasized that the March 1962 storm was a 45-year event in the Ocean City area.

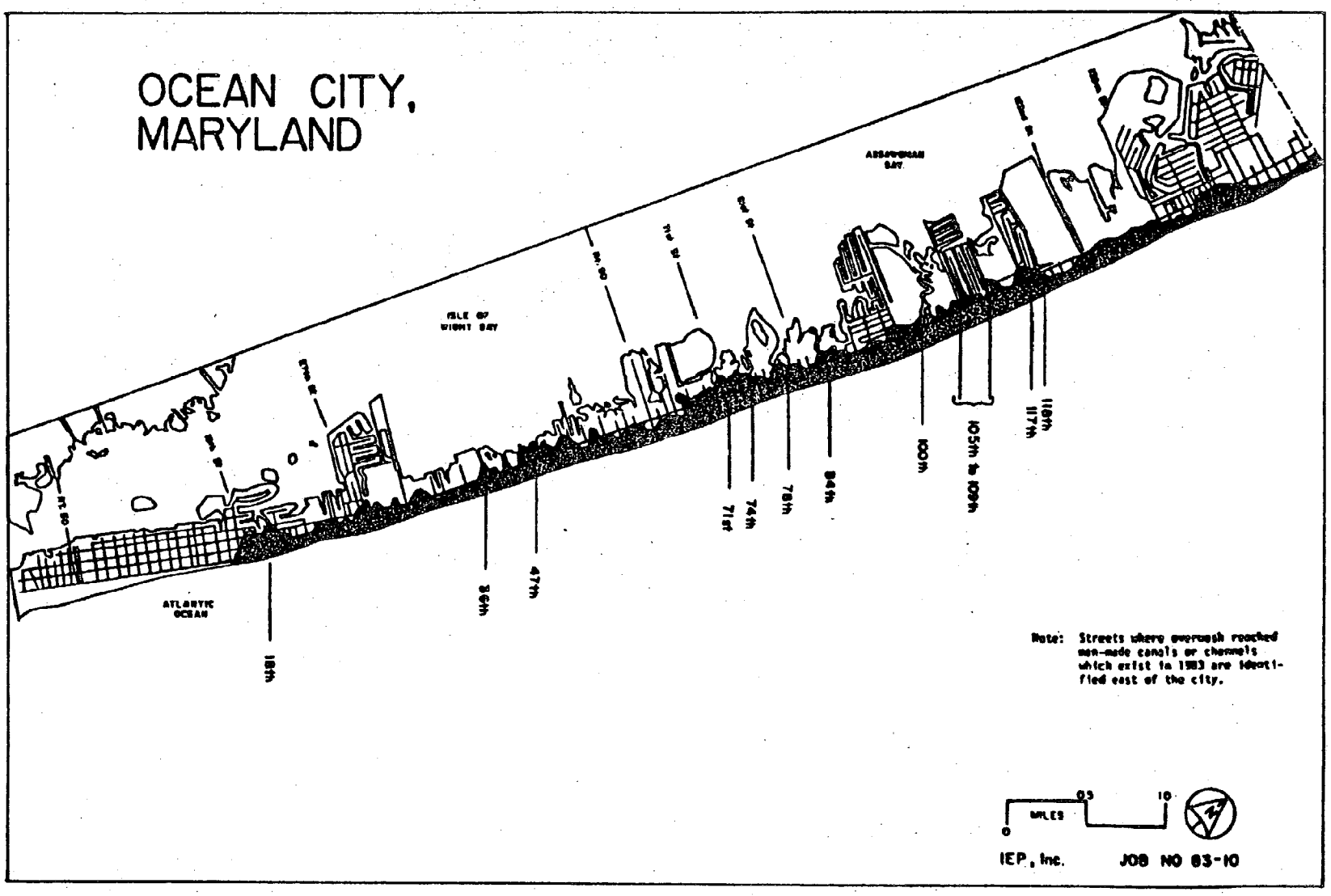


Figure 8. Approximate extent of sand deposited by overwash processes during the March 1962 storm.

Comparative Analysis of Historical and Predicted Storm Impact

A qualitative comparison of the March 1962 storm with the 1983 FIRM based on the extent of overwash represented in Figure 8 was made for 10 segments and briefly described as follows:

1. between the Inlet and 14th Street, no overwash occurred in the B-zone;
2. between 14th and 27th Streets, an area between one and two blocks wide was overwashed and is currently delineated as a B-zone;
3. between 27th and 34th Streets, overwash extended across the Coastal Highway and into the A-zone (elevation six feet);
4. between 34th and 41st Streets, overwash generally did not reach the Coastal Highway and would have been maintained within the A-zone (elevation nine feet);
5. between 41st and 52nd Streets, overwash generally extended across the Coastal Highway and reached the bay;
6. between 52nd and 67th Streets, overwash generally did not cross the Coastal Highway and would have followed the A-zone (elevation nine feet) delineation remarkably close;
7. between 67th and 85th Streets, overwash entirely crossed the Coastal Highway and generally extended into the A-zone (elevation six feet);
8. between 85th Street and Channel Bouy Road (approximately 112th Street), overwash entirely crossed the Coastal Highway and generally followed the A-zone (elevation nine feet) delineation;
9. between Channel Bouy Road (approximately 112th Street) and 118th Street, two extensive washovers crossed what would have been A-zones (elevation eight feet and elevation six feet); and,

10. between 118th Street and the Maryland-Delaware line, overwash generally did not cross the Coastal Highway and generally followed the A-zone (elevation nine feet) delineation.

Summarizing the comparison (see Figure 9), there was a good correlation between the extent of 1962 overwash and the 1983 delineation of the A-zone (elevation nine feet) for 60 percent of the shoreline. There was a poor correlation between the extent of overwash and any A-zone delineations, and overwash primarily extended into the back barrier (A-zone, elevation six feet) for 40 percent of the shoreline. This relatively poor correlation emphasizes the variability and unpredictable nature of overwash processes and flood hazard delineation.

The most dramatic overwash and threat of inlet formation during the 1962 storm occurred in the vicinity of 71st Street. Bulldozing of sand into the breached area prevented the formation of a new inlet.

Barrier Width and Bay Shoreline Configuration

The island remains quite narrow in portions, particularly between 32nd and 61st Streets where it is less than 1000 feet from the Coastal Highway to the Bay. The island is widest north from 87th Street to the Maryland-Delaware line, except in areas where canals have been dredged. But in this area, 14 man-made canals and two natural tidal channels are present, nine of which are less than 500 feet from the Coastal Highway. Overall the barrier varies in width (from the Coastal Highway) between 4900 feet at 133rd Street and 230 feet at 36th Street, and 37 canals and channels have been constructed along the bay side of the island.

The significance of barrier width relates to the vulnerability and isolation of areas by high water and overwash sand deposition. The narrowest sections are likely to be the most difficult to pass while

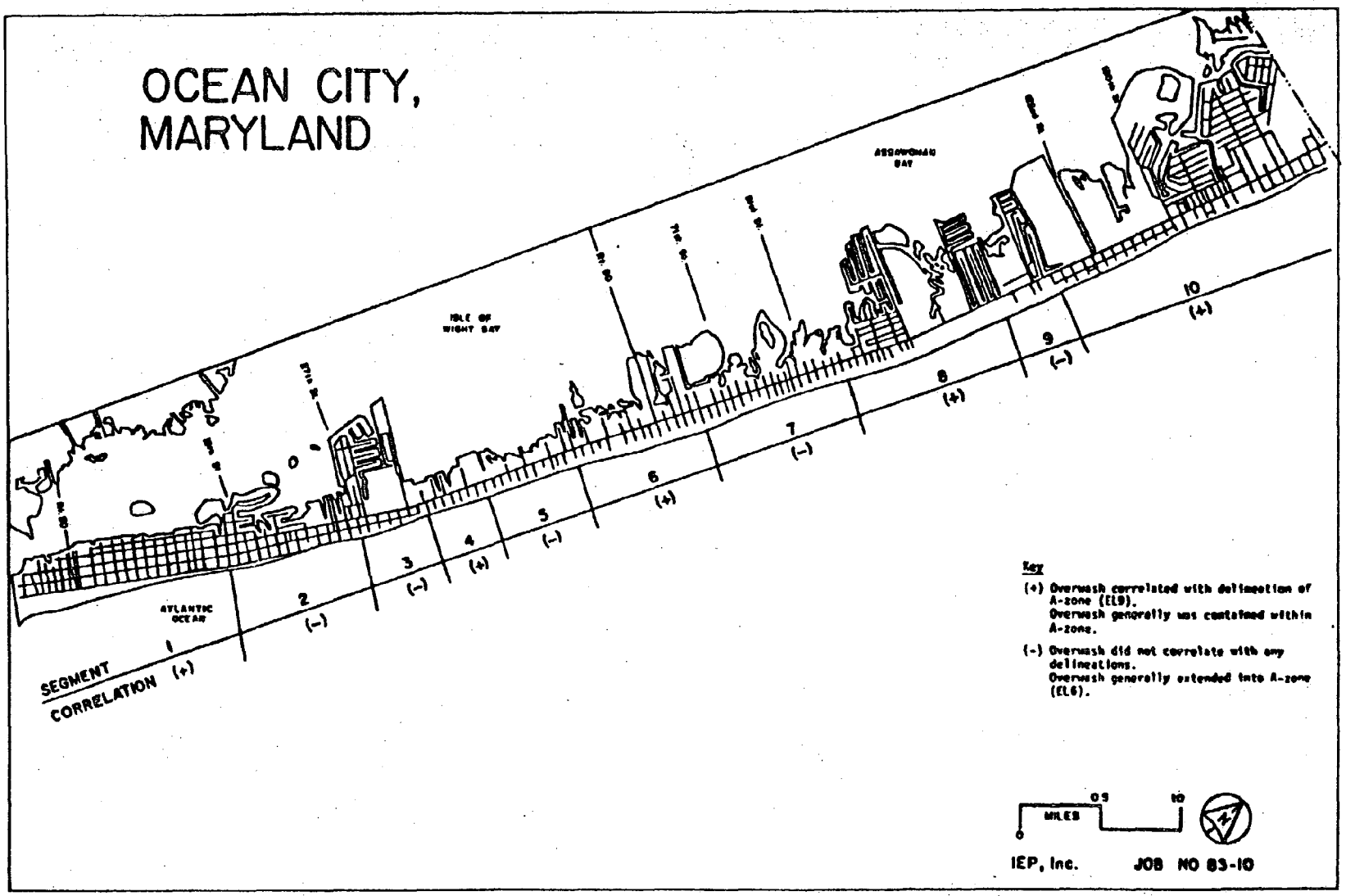


Figure 9. Qualitative comparison between March 1962 storm overwash and 1983 FIRM.

evacuating during a storm because streets oriented perpendicular to the shoreline will carry overwash debris and water onto the Coastal Highway. In addition, narrow sections and canal or channel sites will be vulnerable to breaching and possible inlet formation (as discussed later). The implication is that every effort should be taken to evacuate the island before a storm occurs because once a storm hits, travel on the island will be hazardous.

The lack of efficient storm water drainage, resulting in impounded water on streets, parking lots and other paved areas, affects Fenwick Island's ability to respond naturally to storm conditions through infiltration. During a major storm event, high water levels will impede rescue, evacuation and immediate storm response. The lack of efficient drainage becomes a post-storm problem and will impede recovery and restoration. During minor storm events, rainfall contributions may create "major stormlike" conditions during and after the event. Adequate drainage could reduce these problems, but might not be feasible because of low, flat topography. Ocean City is giving consideration to undertaking measures to improve drainage from Coastal Highway.

Barrier Geology

A geomorphic evaluation of storm susceptibility of a barrier island should also involve a consideration of the three-dimensional stratigraphy of the island. For a landward migrating barrier, the upper sand surfaces of the island roll over top of underlying sedimentary environments that were previously in more landward positions. Accordingly, coring down through barrier beach sands should reveal previous stands of the salt marsh and other vestiges of previous bayside sedimentary environments. Dating these buried salt marsh peat deposits can provide an indication of the rate to which the barrier island migrates landward. The younger the age of the peat, other factors held

constant, the faster the island is migrating. Since barriers migrate by undergoing erosion on their oceanward sides concurrent with bayward accretion, an island that is found to be rapidly migrating is more likely to sustain severe erosion and related damage in storms. Unfortunately, there is presently no three-dimensional data available for Fenwick Island, Maryland.

Three-dimensional stratigraphic modeling of barrier islands based on core and auger data has been undertaken for the south shore of Long Island (Leatherman, 1983). The results of this study indicate that certain portions of the Fire Island barrier system migrate much more quickly than others. The availability of similar data for the Maryland barrier system would aid in prediction of long-term shoreline dynamics and coastal flood hazards.

Two-dimensional stratigraphic studies are also useful in determining the depth to the sand-clay interface under a barrier island. Since sand is much more easily erodable than clay, inlets may preferentially breach through portions of the barrier where the sand layer is thickest. The sand saturation that occurs immediately prior to inlet breaching is aided by the presence of a considerable depth of beach sand since clay is less permeable to water.

The Maryland Geological Survey (MGS) has collected well log and bore hole information to determine the depths to the sand-clay interface along the length of Fenwick Island and has obtained a two-dimensional view. The areas with a generally deeper sand-clay interface can be inferred as being more likely to undergo the severe erosion and scouring that accompanies inlet formation.

Depth to compact clay under Ocean City varies from less than 10 to more than 50 feet along the length of the island according to data provided

by the MGS. Figure 10 shows the irregularity of the subsurface sand-clay interface and so called "buried valleys" that may exist as a result of past inlet positioning. There appears to be four areas where the depth to sand would increase the likelihood of new inlet formation in the event of down cutting during storm conditions. The deepest "buried valley" is located near 83rd Street, where the clay contact is encountered at more than 50 feet below mean sea level. Valley structures are also present in the general vicinity of 37th, 60th and 100th Streets. Other things being equal, these areas should be more vulnerable to inlet formation and breaching during extremely large storms.

THE 100-YEAR FLOODPLAIN FOR WORCESTER COUNTY

The westernmost shoreline of Isle of Wight and Assawoman Bays comprises an extensive area of salt marsh, agricultural land, rural development and several small towns. This part of Worcester County is protected by Fenwick Island during coastal storms to the extent that no waves greater than three feet in height are predicted to occur there (FIS, 1982). Four reaches were studied for insurance purposes and they include:

1. Ocean City Back Channel/Upper Sinepuxent Neck, West Ocean City to Dog and Bitch Islands;
2. Isle of Wight Bay/Upper Sinepuxent Neck, Turville Neck, Jenkins Neck, St. Martins River outfall, and west side of Isle of Wight;
3. St. Martin River/North and South Banks from outfall at Isle of Wight upstream to Piney Island; and,
4. Assowoman Bay/East Side of Isle of Wight, St. Martins Neck, Greys Neck and Dirickson Neck.

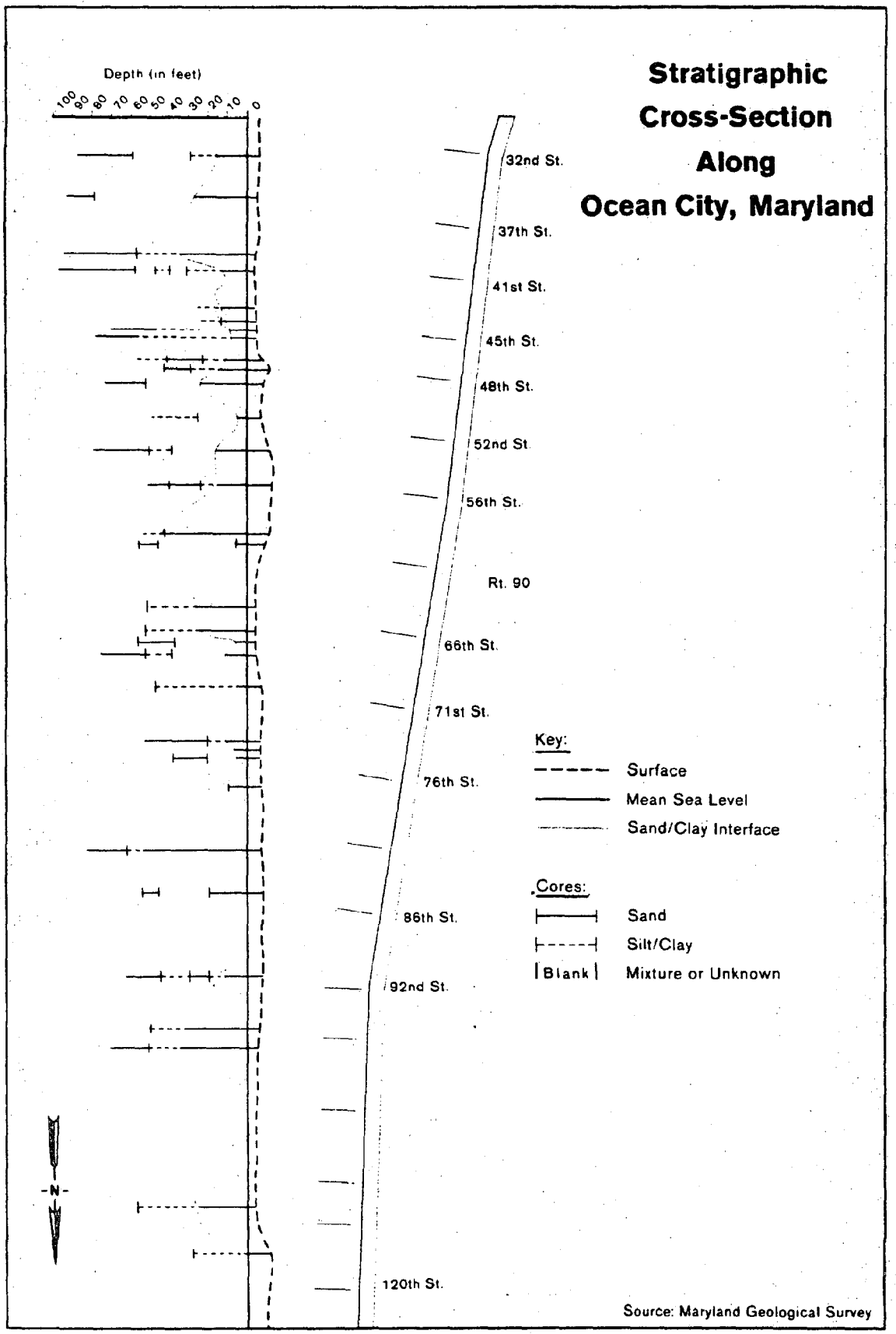


Figure 10. Existing subsurface geologic data revealing possible "buried valleys" in the vicinity of 37th, 60th, 83rd and 100th streets.

The maximum wave crest elevation through reach number 1 which connects Ocean City Inlet with Isle of Wight Bay is ten feet (NGVD) and for the other reaches, numbers 2, 3 and 4, the 100-year surge elevation is six feet (NGVD). Aside from a one foot increase in elevation for part of reach number 1, no major change in the 100-year floodplain occurred since the prior study in August 1978.

The Worcester County bay shoreline can be divided into areas north and south of the St. Martin River for purposes of discussing the extent of development, as well as storm vulnerability. The area south of the river is closer to Ocean City Inlet, has more existing development, has more land prepared for future development and includes Routes 50 and 90 which will be used for evacuation purposes from Ocean City. The closer proximity to Ocean City Inlet may present more vulnerability to the flooding hazard than is identified on the FIRMs because the tidal range in Isle of Wight Bay is larger than in Assawoman Bay. Much of the developed land and land to be developed consists of extensive low-lying dredged and filled areas extending into the bay. Areas along Golf Course and Keyser Point Roads, Turville and Mankiln Creeks and in Ocean Pines should consider minimum elevations for building above the six foot flood elevation identified on the flood insurance maps. Heightened discharge of the St. Martin River also contributes to the flood hazard.

Areas north of the St. Martin River have extensive marshlands that act to buffer upland areas from rising bay waters. The tidal range is less than that closer to Ocean City Inlet making the six foot elevation a good minimum flood level. Areas along Goose Pond, Grey's Creek and in Little Georgetown are being developed in the 100-year floodplain.

ISLE OF WIGHT AND ASSAWOMAN BAYS

These two bays located south and north of the Route 90 bridge, respectively, differ in several ways. Isle of Wight Bay has a three mile width (west to east) that is approximately equal to its length (north to south) and has a fairly uniform depth of four feet below MLW. Isle of Wight Bay has two major channels: one just west of Fenwick Island, and another paralleling the west side of the bay, passing close to shore at the Route 50 Bridge and at the north end of Captains Hill in West Ocean City. Both are deep and have strong currents, and both are migrating away from the center of the Bay. This migration has caused numerous bulkhead failures along Edgewater Avenue in Ocean City and in Captains Hill. Some of these bulkheads have collapsed with surprising speed. In the presence of a major storm, a number of these older structures and their backfill could be lost, threatening houses and apartment buildings with undercutting. Bulkheads in these areas are gradually being replaced, with 40-50 foot long steel pile sheeting being needed in a number of areas.

In contrast, Assawoman Bay is longer (five miles) than it is wide (2.5 miles) and has a more distinct channel (approximately six feet below MLW) bordered by an extensive tidal flat (two feet below MLW) behind Fenwick Island. About 85% of the discharge through Ocean City Inlet comes from these two bays, with the remaining 15% coming from Sinepuxent Bay to the South. The 100-year flood stage decreases toward the north gradually from 8.1 feet at Ocean City Inlet to 5.6 feet near the Maryland-Delaware line (Corps of Engineers, 1980). Overall, data from the Corps and the Flood Insurance Studies compare quite well, although the Corps flood elevations are generally higher (see Table 5).

Bayside Flooding of Ocean City

A major shortcoming in the wave height methodology used in the 1983 FIS was not accounting for the hazard of the ebb surge flowing over the island as a storm has passes from the area. In addition, waves may actually form along the bay side of a barrier and this was not addressed by the wave height methodology.

During a hurricane, increased rainfall, heightened discharge of tidal rivers (St. Martin River) and an easterly wind direction all contribute to the impounding of vast quantities of water in the bay behind the barrier island, particularly along the mainland shore. A rapidly moving hurricane can pass over Fenwick Island and the winds abruptly shift around and blow strongly from the west or northwest. The impounded water is then pushed toward the barrier and Ocean City Inlet. Bay waters pose an increased flood hazard to developed low-lying filled land. Several areas in Ocean City that were once marshlands have been filled and channelized. The banks of these areas have been bulkheaded; however, the elevation of these areas remains low. Construction standards in these flood hazard areas should address bay floods in addition to ocean floods.

Threat of Inlet Formation

Existing canals and channels, previously discussed, will offer a pathway for ebbing bay water and act to channelize high velocity waters. Weakened portions of the barrier could be breached and serve as outlets to the ocean for ebbing tidal waters. Island breaching and inlet formation is a very common occurrence because of this condition. Overwash channels formed during a storm most often serve as natural pathways for inlet breaching. When overwash channels are aligned with man-made canals the possibility of inlet formation is increased. From Figure 8, note the proximity of overwash occurrence in the March 1962 storm to existing canals or channels can be noted at 12 street

Table 5. Comparison of the Estimated 10-year, 50-year, and 100-year Bay Storm Elevations (NGVD in feet) Predicted by Corps of Engineers/Flood Insurance Study Data.

Segments[1]	100-year	50-year	10-year
1	8.1/7.8[2]	7.3/6.7	5.4/5.5
2	7.5/7.3	6.7/6.0	4.9/4.5
3	5.6/5.6	4.4/4.6	2.8/2.9

[1]

Corps of Engineers	Flood Insurance Study
1. 27th Street to Inlet	1. 15th Street to Inlet
2. 90th to 27th Streets	2. 27th to 15th Streets
3. MD/DE line to 90th Streets	3. MD/DE line to 27th Street

[2] Corps/Flood Insurance Study Elevations

locations. Six inlets have been formed during past storms within eight miles of Ocean City Inlet (see Figure 11), but it is not known how many were formed from the bayside.

Ocean City Inlet, as the nearest link between the Atlantic Ocean and coastal bays, remains a topic of general discussion. Many problems are currently being addressed which include deterioration of the South Jetty, a 45-60 foot scour hole at its base, additional dredging and continued migration of Assateague Island. The impacts of the alternatives to solving these problems as they relate to the flood hazard vulnerability of Fenwick Island is an important issue, but is beyond the scope of this study.

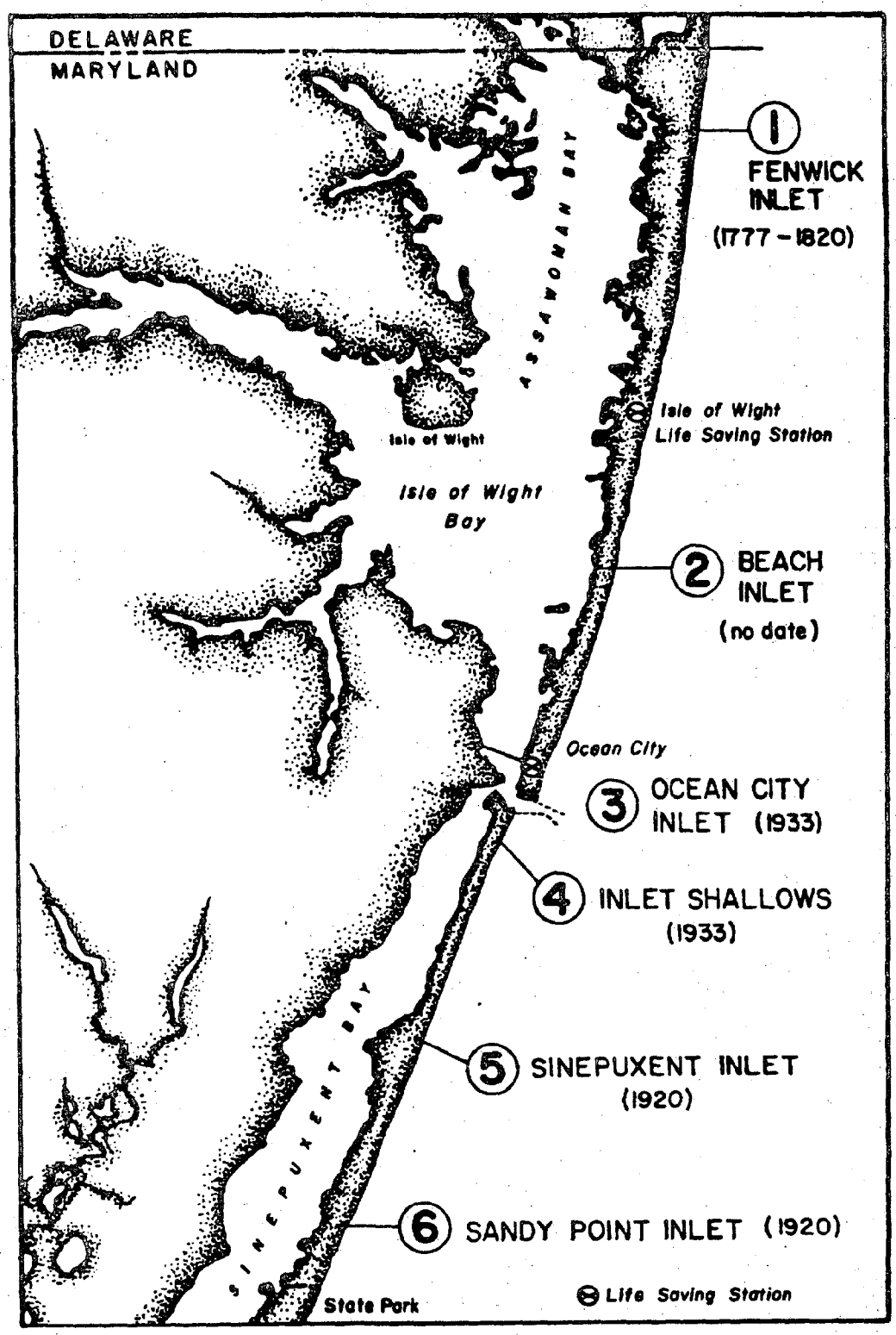


Figure 11. Locations and dates of formation of inlets cut across Fenwick and Assateague Islands during major past storms *(adapted from Truitt)*.

CONCLUSIONS

The flood hazard vulnerability of Ocean City is a function of several geographic, geomorphic, hydrodynamic, and built characteristics that define a developed barrier beach (Fenwick Island). During the last century, this barrier landform has been extensively developed and essentially stabilized in one geographic location. The natural processes of landward barrier migration in response to sea-level rise has been interrupted. Thus, the more Ocean City is developed and the less Fenwick Island is allowed to migrate, the higher the flood damage potential will become.

Five hazard prone areas have been classified for the barrier system and several characteristics have been analyzed in order to identify areas of greatest risk, isolation and breaching during the high (10-year), moderate (50-year) and low frequency (100-year) storm events. The extent of flood and erosion damage caused by these three storm frequency events can be generally depicted (see Figure 12) and described in relation to several cultural features and regulated zones in the city.

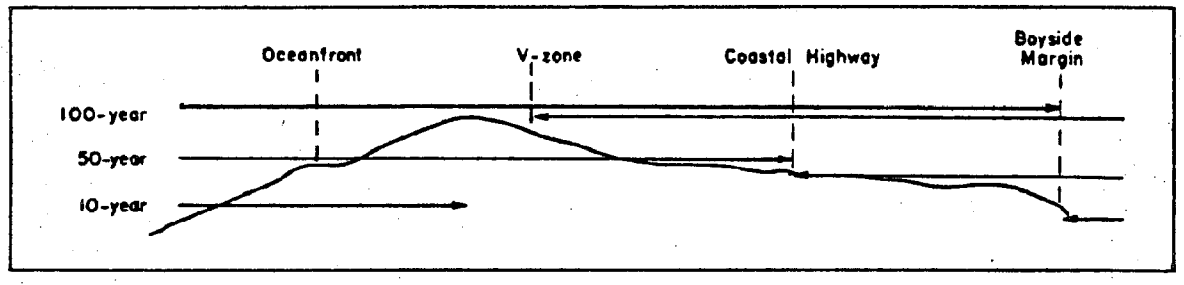


Figure 12. A simplified cross-section of Ocean City showing the general extent storm damage and direction of flooding for certain storm events.

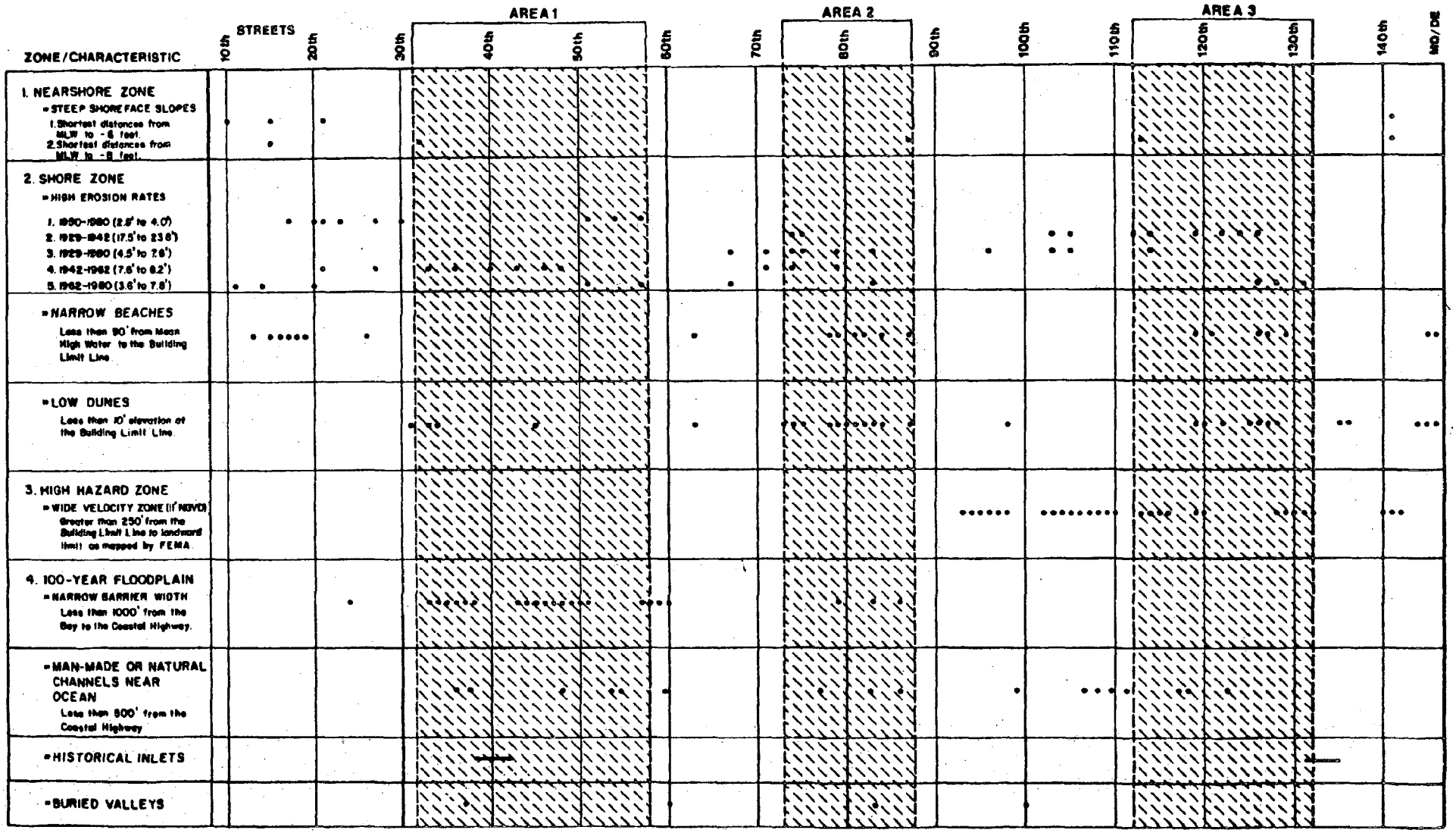
Flood related impacts associated with ocean surges, tides, waves and currents can be expected to extend westward to near the current FIRM

V-zone limits, the Coastal Highway, and the Bays during the 10-, 50- and 100-year storms, respectively. Impacts associated with bay surges, tides and currents, but very little wave action, can be expected to extend eastward to the Coastal Highway and V-zone during the 50- and 100-year storms, respectively. No bayside flooding is expected during the 10-year event, but street flooding from poor drainage of rainwater can be expected. The interaction of ocean and bay waters during moderate to low frequency storms will leave few if any areas isolated from flooding, and will present distinct opportunities for inlet formation to occur.

To be more specific in the identification of greatest risk areas a comprehensive summary of characteristics in each of the five hazard prone areas has been compiled in Table 6. The northernmost eight mile stretch of beach from 10th Street to the Maryland-Delaware line was considered for this analysis and equal weight was given to these characteristics.

Three high risk areas were identified based on the total number of characteristics (e.g., three or more) found at a particular street and the total number of characteristics represented by a group of streets. Area 1 was identified between 32nd and 57th streets because of a steep shoreface slope, high erosion rates (1850-1980; 1942-1962; and, 1962-1980), low dunes, narrow barrier width, several bayside channels near the ocean and an historical inlet location. Area 2 (i.e.,, 74th to 87th street) has a steep shoreface, high erosion rates (1929-1980, and three intermediate time periods), narrow beaches, low dunes, a narrow barrier width and several channels near the ocean. And Area 3 (i.e.,, 112th to 132nd streets) has a steep shoreface, high erosion rates (1929-1942; 1929-1980; and, 1962-1980), narrow beaches, low dunes, wide V-zones, channels near the ocean and an historical inlet location.

Table 6. Areas of Greatest Risk Selected on the Basis of Several Geomorphic and Geologic Characteristics.



Note: Each dot represents the relative importance of a particular characteristic in the vicinity of a particular street.

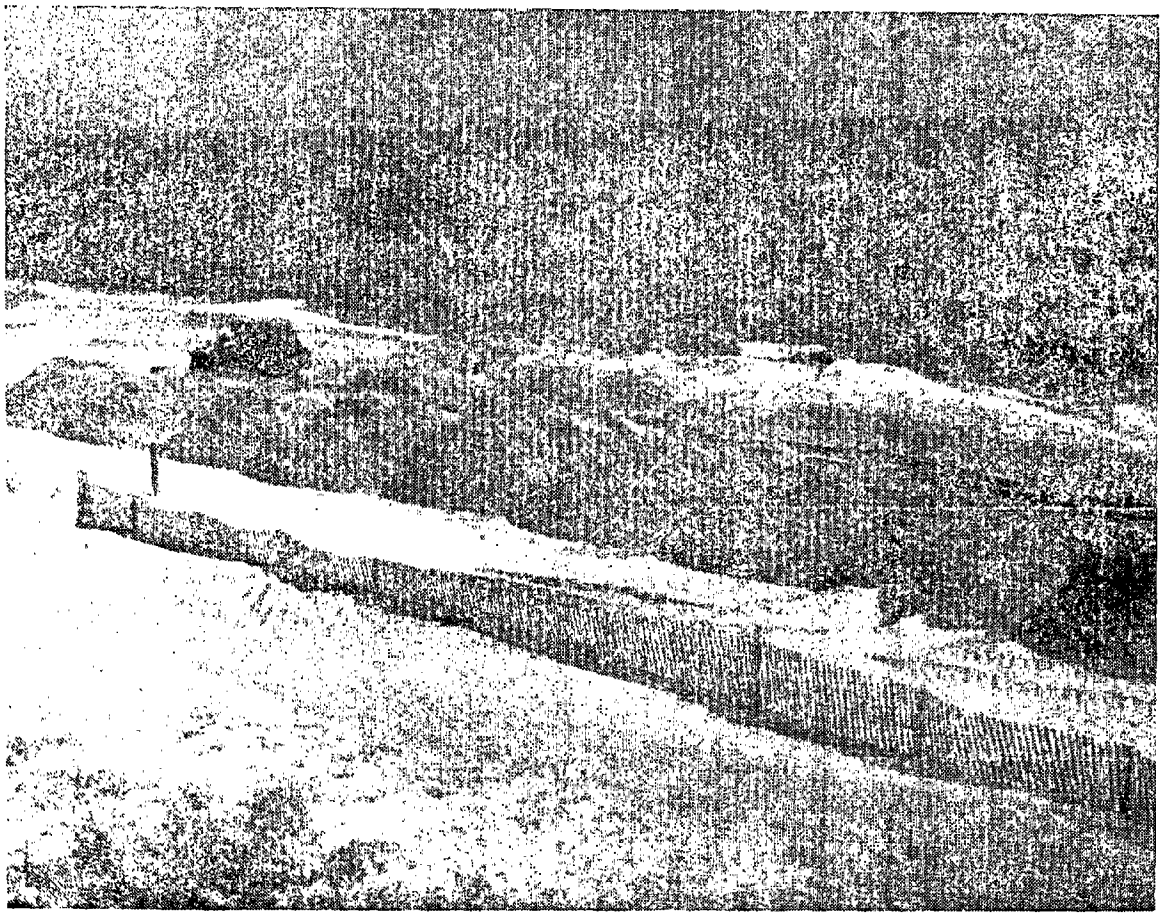
Based on a comparison of characteristics between each risk area, a distinction can be made in terms of vulnerability to a certain storm-frequency event. Narrow beaches and low dunes make Area 2 most vulnerable to a 10-year storm and these same characteristics plus a wide V-zone make Area 3 vulnerable during a 50-year storm in addition to Area 2. Virtually all of the barrier will be vulnerable to change during a 100-year storm, but narrow barrier widths plus bayside channels near the ocean make Area 1 highly vulnerable to the potential of inlet formation. There is reluctance to be any more specific with identification of greatest risk areas because of the unpredictable nature of storm processes; but, those streets having more than four hazard prone characteristics include: 33rd, 74th, 79th, 83rd, 119th and 126th.

In addition to the natural hazard characteristics, built characteristics and their influence on increasing damages cannot be overlooked. Buildings not fronted by vegetated dunes; areas adjacent to seawalls, bulkheads and solid (not elevated) foundations; buildings directly behind seawalls; utilities located close to the ground and buildings with shallow piles on the bayside of the barrier are extremely vulnerable to excessive flood damages. There are also times of greatest concern as they relate to barrier habitation, storm occurrence and high tide events. These include: late summer hurricanes and late spring nor'easters; full and new moon tides; predicted periods when the moon and earth are closest to on another (perigee); and, the long-term future, in general, as long as no short-term mitigation techniques are implemented.

IS

OCEAN CITY

PREPARED?



Ocean City is aware of its location on a barrier island exposed to the impact of hurricanes and northeasters. In the 20 years since the 1962 northeaster caused extensive damage at Ocean City, the City, State and county have developed several regulations and programs that directly or indirectly reduce the potential for flood losses from these storms. At the same time, development at Ocean City has increased the amount of property and number of people that are at risk from a major storm.

This section describes the major regulations and programs relating to flood and erosion control that now affect Ocean City, and examines the extent to which Ocean City is currently prepared to withstand a major coastal storm.

PROTECTING THE LAND

Immediately after the March 1962 storm, the Corps of Engineers developed an emergency plan to clear sand from the roads and rebuild dunes that had been washed away. This plan titled Operation Five-High included beach and dune reconstruction from the Maryland-Delaware line south to Ocean City Inlet. The basic plan consisted of a continuous berm and dune with a dune crown not less than 12 feet above mean low water on a line approximately 150 feet west of the mean high waterline, and the erection of a sand fence extending along the entire dune crown. Much of the sand used was that cleared from the streets, but an additional 1,050,000 cubic yards was pumped in from Assawoman, Isle of Wight and Sinepuxent Bays. As stated in the preface of the document Operation Five-High:

> The dunes constructed by the Corps of Engineers were designed to protect against Atlantic storms as severe as any that are expected to occur in an average 10 year period. State, County and City officials have been informed of the limits of the protection and are here again advised that complete protection has not been provided. Steps should be taken by all interests to preserve the constructed work by planting grass and shrubs erecting additional sand fences, and to further build up the dunes as protection against storms of magnitude greater than those of a 10 year frequency.

Twenty years of growth and development since the March 1962 storm have eliminated almost all dunes on the island and covered up most other available sand on the island with parking lots, roads, shopping centers

and condominiums. The 10-year frequency storm protection no longer exists; there is now less than 5-year storm protection.

INTERIM BEACH PROTECTION

Several beach protection plans have been developed in the past several years that would reduce Ocean City's vulnerability to coastal storms. One of these, a Corps of Engineers plan (1980), would provide protection from a 100-year flood, but it has not been funded. In April 1982 a formal beach protection plan was agreed upon by state and city officials which provides for the installation of two groins a year for the next 25 years. Beach fill between the groins is required, but no borrow site has been selected as a source of sand for the fill. This plan does not include dune restoration. This agreement was recently formalized in a Memorandum of Understanding between Ocean City and the Maryland Department of Natural Resources with an emphasis being place on the construction of two or more adjacent groin cells (3 or more groins per year starting in FY 1985).

The specific engineering design of the current groin plan is based on recommendations for short groins made in the Trident Report on Interim Beach Maintenance at Ocean City, October, 1979. To be more effective than the existing 52 asphalt, timber and stone groins, the proposed groins will extend further seaward, end at lower point in the surf-zone and be spaced more proportionally according to Corps of Engineers specifications. They will also be built to acceptable engineering design methods. A set of four maps at a scale of 1"=200' and titled "Groin Location Plan for Interim Beach Maintenance" prepared by the Shore Erosion Control Program, Capital Programs Administration, Maryland Department of Natural Resources shows the approximate location of the 50 groins. No existing groins will be removed and some existing groins which meet the spacing criteria will be expanded. They will be

placed sequentially from south to north. Further analysis of the groin plan maps indicates that ten will be built on existing groins, 12 will be expansions to existing groins that meet the spacing criteria and 28 will be newly constructed. Seventeen existing groins, now exposed, will remain with the field. When the plan is completed, 67 groins will be present. Both in the Trident Plan and the subsequent agreement between Ocean City and the Department of Natural Resources, it is noted that no groins will be constructed within one mile of the Maryland-Delaware State Delaware State line without coordination with the Delaware Department of Natural Resources to ensure that Delaware's beach areas are not adversely affected by the groin construction. The basic difference between the plan agreed by Ocean City and the Department of Natural Resources and the Trident Plan is that the Trident Plan anticipated the completion of the entire groin system within five years and emphasized the need for sand fill between the groins while the rate of groin construction under the agreement will be considerably less and could take up to 25 years.

The placement of the first two groins was completed at 7th and 9th Streets in May 1983. The state legislature allocated the estimated $350,000 it would cost for the two groins; however, with an additional $90,000 the project was still 10-15% over budget. Some of the high cost is attributed to difficulty in some of the construction methods. More importantly, the space between the groins was not filled with sand and their effectiveness is thus suspect. The purpose of the new groins is to hold the new sand longer; therefore, filling the groin cells to capacity is a primary design requirement.

Several areas have been identified for source sands to be used in the groin plan: three areas offshore; at least two areas in Isle of Wight Bay; and, at the North Jetty. An offshore site located seaward of Ocean City Inlet is a sand source which could be reduced because of its

association with the inlet (Dean, 1977). Costs, logistics and environmental problems of bringing sand in from offshore and the bay have been primarily responsible for these sources not being selected. Legal and political problems cloud the alternative of using sand at the North Jetty. But, a very innovative and cost-effective approach can be implemented that would recycle the sand there. A pumping system, entirely on land, could transport sand from the end of the north jetty to the groin cell. Sand that eroded from or bypassed the groins would be trapped at the jetty. The sand would continue to be pumped back to the beaches as it came to the jetty.

Ocean City's current objective is to begin implementing a plan which meets their immediate needs for erosion control and provides for additional recreation area while the more extensive Corps plan (COE, 1980) awaits funding. The Corps has emphasized that (1) recreational projects have a very low priority and it is doubtful the plan will get approval, and (2) their plan doesn't utilize groins so no reimbursement will be made for groin work done now by the City (pers. comm. Robert Linyer, U.S. Army Corps of Engineers, Baltimore District, 6/8/83). Given the Corps position, the city needs to begin planning for an alternative means of providing long-term protection while an interim plan is implemented. Implementation of a long-term plan with another source of funding without any interim protection might also be considered.

It is imperative that the public, and particularly the property owners, recognize that the groin plan is designed to provide a wider beach (if cells are filled to capacity) for recreational purposes and perhaps reduce the frequency of beach nourishment. The groin plan is not an effective means of protecting buildings from coastal flood damages. A wider beach may cause storm waves to break further seaward, but levels of flooding will not be reduced. In addition, updrift accretion and

downdrift erosion caused by groins is more of a rule than an exception. Both have occurred locally because of the North Jetty; it can occur on a smaller scale. On a more positive side, the wider beach will contribute to a more successful dune stabilization effort.

BEACHFACE BULLDOZING AND DUNE STABILIZATION

Other erosion and flood control efforts which occur on an emergency basis have been limited to isolated areas. Beginning with an emergency authorization in June 1976, bulldozing of beach sands to form dune-like mounds has apparently become an accepted form of beach maintenance. The largest direct expenditures that have been documented include approximately $136,000 in October and November 1977 and approximately $648,000 between December 1977 and February 1978. State reimbursement totalled $250,000 for these periods. The bulldozing occurred without study of the actual effect it had on beach erosion, but generally, the effort is not considered to have long-term value (Public Hearing testimony, June 7, 1977) and a diminishing value as offshore slopes steepen (Trident, 1979). A request by the Department of Interior Fish and Wildlife Service to the Corps of Engineers on September 21, 1977 focused on the need for monitoring either by the applicant (city), Corps of Engineers or the Maryland Shore Erosion Control Program and the Maryland Geological Survey to determine "...amount, frequency and overall effectiveness of bulldozing as a beach maintenance technique." Kerhin and Halka (1981) concluded that bulldozing the beachface is futile in that it steepens the profile and simply accelerates later erosion of the backshore.

Private efforts to establish and stabilize dunes in front of their property have been organized through the Ocean City Dune Stabilization Committee. Their goal is to organize property managers and owners to act in the most effective, technical and economic manner to enhance and

develop a protective dune line. Less than 20 percent of the sites had maintained dunes in 1982. The goal is to have a complete maintenance program by 1987. An "Ocean City Dune Packet" is distributed which lists key committee members, highlights the value costs and schedule of due establishment, identifies types of plants, recommends fertilizers and lists helpful publications. The packet is trying to promote the following nine objectives:

1. Increase the number of property owners/managers interested in property protection through dune stabilization.
2. Establish a procurement committee whose charge it is to determine the cheapest and best methods to acquire fence materials, fertilizers, plant materials, labor and other materials as needed.
3. Establish cooperative relations with all divisions of government interested in proposed activity and others that might be of assistance including conservation oriented groups.
4. Obtain assistance in developing a conservation and dune development and stabilization plan for each land owner who is a member of the group.
5. Establish a preference for early dozer work for participants of the dune stabilization program if the city continues to doze sand.
6. Follow the dune development and stabilization suggested schedule of activities.
7. Document successful and unsuccessful dune development and stabilization attempts and the reasons why.
8. Twice a year (May and September) select a committee whose charge it is to view the dunes and identify maintenance work that need to be accomplished.
9. Inform the public through news articles of all activities of the organized group. Establish an information campaign to increase and retain group membership.

The Worcester County Soil Conservation Service completed a follow-up study of the dune stabilization project along the ocean front in the summer of 1983. The results for a total of 241 sites are as follows:

Vegetation:

1. Approximately 66% of the sites were completely devoid of any appreciable vegetation.
2. Only 2% were considered to be "natural and well covered."
3. 7% were "natural and sparse."
4. 8% were considered to have "natural and medium" coverage.
5. 7% were "planted and well covered."
6. 6% were "planted and medium."
7. 4% were "planted and sparse."

Fencing:

1. 60% of the sites had no fencing at all.
2. 4% were covered with less than 24" of the fence showing.
3. 6% were "broken down - inadequate for dune formation."
4. 30% of the sites were "adequate - in good shape."
5. Virtually all of the sites with the exception of those between 94th and 115th streets were easily accessible, i.e.,, the sites were not adequately protected by fencing.

Dune Height:

1. 42% of the sites averaged less than 1 foot of height.
2. 11% of the sites averaged 1 foot to 3 feet in height.
4. 25% were 5 feet in height or greater. 3. 22% averaged 3 feet to 5 feet.

Vegetative Appearance:

1. 66% of the sites were devoid of vegetation.
2. 26% of the vegetation was considered to be green or vigorous.
3. 8% was considered to be yellow or stressed.

Dune Formation:

1. 58% of the sites had some type of dune formation.
2. 42% of the sites had no dune formation.

While these efforts must be applauded and further participation encouraged, the fact remains that the width of the current beaches is not large enough to maintain the dunes for long-term protection. More involvement by property owners and managers to expedite the restoration of Ocean City beaches will not only benefit their own dune stabilization efforts, but further protect the longevity of the buildings behind them.

PROTECTING PROPERTY

Several land use and building controls established by State, County and City authorities are specifically intended to protect property from damage by floods and storms. The major programs and legal controls enacted by each level of government are discussed below.

STATE OF MARYLAND AUTHORITIES

Flood Hazard Management Act of 1976.

This Act establishes the basic floodplain management and flood hazard mitigation authorities for both the State and local governments. It is administered by the Water Resources Administration, Flood Management Division, of the Maryland Department of Natural Resources (DNR). The Act is significant both for its explicit recognition of the need to mitigate flood losses and for its requirement that State and local governments establish programs for flood loss reduction. The Act states that "the public interest necessitates management of waters and flood hazard areas for the objectives of preventing and alleviating flood threats to life and health, reducing private and public economic losses, and to the extent possible, preserving the biological values associated with these land and water resources."

The Act places responsibility for action to reduce flood losses on both State and local government. DNR is required to designate priority watersheds for conducting flood control planning and management studies. DNR is then required to fund and prepare these watershed management studies. The study may be prepared directly by DNR or delegated to the local jurisdiction. A watershed management study which will include Ocean City and Worcester County is scheduled to begin in the spring of 1984. This study, to be funded and prepared by DNR, will utilize the information

contained in this present study as a basis for developing more detailed information on flood frequency and magnitude under existing and planned conditions and identify alternative management techniques.

Following completion of a watershed management study, the Act requires the local jurisdiction to prepare a flood management plan based on an evaluation of the alternative management techniques and other findings included in the watershed management study. Once the plan is approved by DNR, the local jurisdiction must then adopt a program to implement the flood management plan. Specific capital projects to implement the plan may be eligible for cost-sharing funding from the State. Priority for funding is given to those projects which provide long-term solutions, do not require maintenance, and have minimal adverse environmental impacts.

Flood Insurance Program.

The Flood Management Division also provides coordination with the National Flood Insurance Program administered by the Federal Emergency Management Agency (FEMA). It provides assistance to local government in developing floodplain management regulations and reviewing flood insurance studies and maps prepared by FEMA or the Department itself. The Flood Management Division also assists FEMA in conducting Community Assistance Program Evaluations (CAPE's) which are designed to determine if a local community's regulations are in compliance with the minimum requirements of the National Flood Insurance Program and are being adequately enforced. FEMA and DNR have performed two CAPE's on Ocean City in the past few years, and found that Ocean City is largely in compliance with National Flood Insurance Program regulations (see section on Ocean City for further discussion).

Shore Erosion Control Law.

The Shore Erosion Control Program of DNR provides technical and financial assistance to property owners with shore erosion problems. Individual

landowners, municipalities and counties may apply for 25 year, interest-free loans for projects designed to control shore erosion. Construction loans cover 100% of the first $50,000, 50% of the next $20,000, 25% of the succeeding $20,000, and 10% on any remaining amounts. DNR supervises the design and construction of the structures, but property owners are responsible for maintenance.

To date, only one shore erosion control structure has been constructed along Ocean City's oceanfront under the provisions of this law. In response to a request from a group of owners of the Oceania Condominum located between 82nd and 83rd streets, DNR provided a 25-year interest-free loan in the amount of $120,000 to construct a sheet steel bulkhead to protect the Oceania Condominums from further beach erosion. The bulkhead is approximately 260 feet long.

Sediment Control Law.

This Act and associated Sediment Control Rules and Regulations are administered by the DNR Erosion and Sediment Control Divison. Each county and municipality is required to adopt grading and sediment control ordinances. Approval of sediment control plans for construction projects is required by the appropriate Soil Conservation District and, in some cases, by DNR. DNR provides technical assistance to local governments and the soil conservation districts, and periodically evaluates the local governments' grading and sediment control programs as to their overall effectiveness in implementing the provisions of the Sediment Control Law.

Beach Erosion Control District/Building Limit Line.

Included within the Sediment Control Law is a provision creating a Beach Erosion Control District and a Building Limit Line that extends from the Delaware line to the Virginia line. This Building Limit Line legislation was enacted in 1975 following several years of controversy over dune

restoration and maintenance and the issuance of building permits on and seaward of the dunes. The State had intervened on at least one occasion, seeking to prohibit the construction of a home being built on the beach. After losing in court, the State enacted the Beach Erosion Control District Act.

On Assateague Island the western boundary of this district is approximately the west crest of the existing natural dune line. In Ocean City the western boundary is a line known as the " State-Ocean City Building Limit Line which coincides, more or less, with the existing established Ocean City Building Limit Line and on occasion may coincide with the crest of the littoral system." The Building Limit Line was surveyed by the State and recorded in April 1976. Construction of permanent structures within the Beach Erosion Control District is prohibited except for those approved by DNR and the Soil Conservation District for storm control, beach erosion and sediment control.

The Beach Erosion Control District Act also provides that "If the prohibitions imposed on the beach erosion control district would constitute a taking of a property right without just compensation in violation of the constitution of the United States or the constitution of Maryland, funds under program open space may be used to purchase or otherwise pay for any property taken." Procedures established by DNR for administering the Act provide that:

- any private owner wishing to sell property within the Beach Erosion Control District may offer to sell the property to the State by notifying DNR.
- DNR must submit the offer to sell the property to the Attorney General of Maryland for review and recommendation as to whether establishment of the District created a taking of property right without just compensation.
- DNR must submit to the Department of General Services those properties

which the Attorney General recommends for compensation.

- DNR may recommend purchase of other properties located within the Beach Erosion Control District, provided there is a clear advantage to the State of public ownership.

In 1975 it was estimated that approximately 10 acres of property might need to be acquired because of denial for building permits. To date, the State has acquired through the Program Open Space a total of 34 1/2 lots (5.2 acres) from 19 different property owners. Land acquired by the state under this program is maintained as open space to provide greater beach access and beach area.

Stormwater Management Act.

This 1982 Act requires each county and municipality to adopt, by July 1, 1984, ordinances necessary to implement a stormwater management program. The Stormwater Management Division of DNR has developed regulations setting forth minimum stormwater management requirements for each county and municipality.

State Wetlands Act.

This Act defines two categories of tidal wetlands: State wetlands and private wetlands. State wetlands are defined as "all land under the navigable waters of the State below the mean high tide, which is affected by regular rise and fall of the tide." Private wetlands are "all lands not considered State wetlands bordering on or lying beneath tidal waters, which are subject to regular or periodic tidal action and which support aquatic growth." The Wetlands Division of DNR reviews, and permits if appropriate, all proposed activities in private wetlands, except for certain hunting, fishing and agricultural activities which are automatically permitted. The Board of Public Works makes the final decision on permitted activities within State wetlands. The same permitting policies generally apply to both State and private wetlands. This program

is carried out in coordination with the Corps of Engineers Section 404 Permit Program, and DNR has a Memorandum of Agreement with the Corps for a joint permit review program.

Prior to passage of the Wetlands Act, considerable dredging and filling, including the creation of canals, occurred on the bay side of Ocean City. Most of this dredge and fill activity is now prohibited.

Coastal Zone Management Program.

The Tidewater Administration of DNR administers the Maryland Coastal Zone Management Program. This program operates primarily by providing technical assistance to, funding for, and coordination with State and local programs to ensure that the objectives and policies of the CZM program are carried out. With respect to floodplain/watershed management activities, the program has assisted stormwater management and erosion and sediment control study efforts, floodplain mapping efforts, the development of watershed management plans, and project reviews. The Tidewater Administration is sponsoring this current study of the Ocean City area in a cooperative agreement with the Water Resources Administration with funding provided by the FEMA State Assistance Program.

The State programs briefly described above provide the greatest and most direct potential for flood loss reduction in the Ocean City area. Other State programs can also affect the degree of flooding that may be experienced or the amount of damage that may occur, such as the State Highway Administration's programs and policies for design and location of State highways, the Department of State Planning's development policies and review and development of funding priorities for State funded capital projects, and the Maryland Emergency Management and Civil Defense Agency's programs for flood preparedness.

OCEAN CITY, MARYLAND AUTHORITIES

The Code of the Town of Ocean City contains the following major provisions specifically related to flooding and erosion.

Section 34. Building Construction.

The Standard Building Code published by the Southern Building Code Congress International, Inc. has been adopted as the Building Code of the Town of Ocean City. Appendix M, Flood Plain Construction Standards, of this code provides performance criteria for elevation, anchoring and construction materials for buildings to be constructed in flood hazard areas, based on the minimum regulations established by the Federal Insurance Administration for the National Flood Insurance Program. It also includes by reference some of the standards included in U.S. Army Corps of Engineers 1972 document "Flood-Proofing Regulations." These criteria are provided as guidance rather than as a part of the formal code. The performance criteria can result in varying interpretations of design and construction specifications depending upon the experience and knowledge of coastal flooding design or the architect or engineer involved.

Section 36. Oceanfront Building Limit Line.

This section was adopted in 1971 to prohibit new construction east of a designated oceanfront building limit line. This oceanfront building limit line has since been superseded by the State-Ocean City Building Limit Line which was established in 1975 and closely follows the original Ocean City oceanfront Building Limit Line. In most areas the Building Limit Line is east of the natural dune line.

Section 36. Open Space Implementation Program.

This section also adopts an Open Space Implementation Program, establishes a City policy to acquire by acquisition or easement areas designated in the Open Space Implementation Program, and requires development of

a financing program to fund the acquisition of open space. An "Open Space Program" was developed in 1971 that described a proposed easement program and a proposed acquisition program, including areas to be acquired and approximate costs. However, according to the City Planner, this proposed program was apparently not maintained and carried out, although the City has acquired several lots and many easements along the beach. A formal Open Space Implementation Program with a separate financing program does not exist at this time, but the City Engineer indicated that the City still acquires easements along the beach when appropriate.

Section 46. Erosion and Sediment Control.

In 1971 two erosion and sediment control districts were established within Ocean City. The Beach Erosion Control District extends 150 feet west of mean low water, or to the highest point of the natural dune if present, or to the point at which surface drainage is eastward, or to the boardwalk, whichever is greatest. The Bay Erosion Control District includes the remainder of Ocean City.

Beach Erosion Control District: Within the Beach Erosion Control District, sediment and erosion control plans must be approved by the Worcester Soil Conservation District before any soil disturbance may occur or building permits may be granted. Buildings may be constructed within the Beach Erosion Control District and the natural dune may be removed. However, a new dune and berm must be established prior to the start of construction. The new dune must include a berm that gradually rises from mean low water to seven feet above MLW at a point 100 feet west of MLW. The dune must then rise to 16 feet above MLW at a point 150 feet west of MLW. All portions of the dune east of the dune crest (and not covered by structures or pavement) to 5 feet above MLW must be planted in suitable vegetation as approved by the Worcester Soil Conservation District.

All buildings constructed within the Beach Erosion Control District must be constructed on steel-reinforced concrete pilings properly engineered and designed to bear the load of the structure and be so certified by a registered professional engineer or architect. The building must also have a vertical clearance of at least nine feet above the berm. Retaining seawalls may be permitted by the Worcester Soil Conservation District, provided that a dune with a minimum elevation of 16 feet MLW is established and can be maintained.

Maintenance of the dune and berm, either natural or newly created, is the responsibility of the property owner. If the property owner provides the Town of Ocean City with a public easement for use of the property within the District, the City may, at its discretion, maintain the berm and dune. However, the City is not obligated to provide this maintenance, and the property owner remains responsible for maintaining the dune according to the original specifications.

In past years the requirement for dune maintenance was not adequately enforced. Berms were often maintained by bulldozing sand from the lower beach, but sand fences and vegetation were not provided to help the artificial dunes becomes established. As a result, there are few dunes remaining in Ocean City.

During the past two years the Worcester Soil Conservation District has taken a more active role in the dune restoration and maintenance program. In 1982, the District surveyed and mapped Ocean City beachfront properties, including their size, vegetation and vulnerability to human destruction. The District has also begun working with a local Condominium Association to encourage property owners to place sand fences and plant dune vegetation. In 1982 54 properties were planted with beach grass in the cooperative project with the Condominium Association, and the District has used news articles, radio and television to encourage property owners to

join the dune restoration project.

Bay Erosion Control District: Prior to any soil disturburance or issuance of any building permit, the Worcester Soil Conservation District must approve the soil erosion and sediment control plans for the proposed activity.

Section 52A. Flood Damage Controls.

This section adopts the Flood Insurance Rate Maps prepared by the Federal Emergency Management Agency and sets floodplain regulations adequate to ensure that Ocean City qualifies for participation in the National Flood Insurance Program. The regulations were initially adopted in 1973 and were last revised in 1983. The Flood Insurance Rate maps were revised in May 1983.

The maps identify A-zones (areas subject to flooding from a 100-year flood), V-zones (areas subject to velocity waters, including hurricane wave wash and tidal waves in the 100-year flood), and indicate expected water levels during a 100-year flood. This section also establishes minimum elevation requirements in the A-zone for residential construction (lowest floor elevated to 10.5 feet above mean low water) and nonresidential construction (elevated to or above the level of the 100-year flood or floodproofed to the level of the 100-year flood).

In V-zones, any permitted construction must be located landward of the reach of mean high tide, be elevated on adequately anchored pilings or columns so that the lowest portion of the horizontal structural members of the lowest floor shall be elevated to or above the 100-year flood level, and have the space below the lowest floor free of obstructions or constructed with breakaway walls. It also prohibits the use of fill for structural support in V-zones, placement of mobile homes in V-zones, and man-made alterations of sand dunes if the alterations would result

in an increase in potential flood damage. Appendix A contains maps showing the relationship between the location of existing structures and these zones.

FEMA and DNR conducted evaluations (CAPE's) of the Ocean City Flood Damage Control regulations in 1976 and 1981 and found that the City was largely in compliance with the regulations. The 1976 evaluation also determined that the water and sewer facilities were reasonably floodproofed. The 1981 evaluation indicated that all mobile homes in the Montego Bay mobile home park appeared to have been adequately anchored. The 1981 evaluation also noted that confusion sometimes exists regarding proper elevations because Ocean City uses mean low water as a local datum instead of NGVD. This resulted in some structures being rated improperly for flood insurance purposes, but apparently had not resulted in construction to incorrect elevations.

Section 54. Foundation Regulations in Critical Areas.

This section establishes more specific and more stringent standards for scour, impact loads, pilings, concrete cover of exposed structural concrete, and bulkheads for building foundations located in defined critical areas. The defined critical areas are 1) east of the easterly right-of-way of Baltimore Avenue between North 10th Street and North 33rd Street, and 2) the area east of a point 265 feet east of the easterly right-of-way of the Coastal Highway from North 33rd Street to the Delaware Border. Structures located east of the Dune Line as defined in Section 46 may require additional measures if the Building Inspector determines that they are necessary to withstand exposure to the elements. This section also specifies that design windloads for buildings located in this area will be those established by Section 120 of the Southern Standard Building Code for Coastal Regions.

Section 105. Zoning.

The zoning regulations of Ocean City establish limits on lot coverage, building size, height, and other standard provisions. They do not contain any provisions specifically relating to location of buildings for flood damage reduction.

Comprehensive Plan of Ocean City, Maryland.

The Comprehensive Plan was first adopted in 1969 and last revised in 1978. Although the plan recognizes the importance of the beachfront to Ocean City and that the City is situtated on a sand spit, it does not specifically address the flood hazard vulnerability of Ocean City, and does not appear to have taken the flood hazard into account in any major way. Ocean City officials have indicated that they intend to revise the Comprehensive Plan in 1984.

WORCESTER COUNTY AUTHORITIES

Ocean City is located within Worcester County, but most aspects of government and regulation of Ocean City are separate from the County. Worcester County has established the following regulations pertaining directly to floodplain management.

Building Regulations: Title 1. Building, Plumbing and Electrical Codes.

The County Commissioners are authorized to adopt uniform building, plumbing and electrical codes governing construction within the County. To date they have adopted the Maryland State Plumbing Regulations as the local plumbing code and the 1975 National Electrical Code as recommended by the National Fire Protection Association as the local electrical code. The Commissioners have not adopted a local building code.

Building Regulations: Subtitle 3. Floodplain Management.

Floodplain Management regulations are included under Worcester County's Building Regulations Authority. As in Ocean City, the regulations adopt the flood insurance rate maps prepared by FEMA as the basis for delineating flood hazard areas and regulating construction and use within them. The latest revision of the FIRM's became effective June 15, 1983. There are no V-zones designated in the area of Worcester County across from Ocean City. The Worcester County regulations require that the lowest floor of residential construction must be elevated to the 100-year flood elevation or higher, rather than specifying a uniform elevation requirement as in the Ocean City code. Nonresidential structures must be elevated to the 100-year flood elevation or floodproofed to the 100-year flood level.

Natural Resources: Subtitle 2. Erosion.

Prior to any type of soil disturbance, a grading plan must be approved by the Worcester Soil Conservation District and a grading permit issued by the Worcester County Sediment Control Inspector. Exempt from this requirement are agricultural land management practices, agricultural structures, single-family residences on lots of two acres or more, and residential and commercial lots under two acres where the only earth movement involves excavations of less than 300 cubic yards. Enforcement of the sediment control program is shared by the Soil Conservation District and the Sediment Control Inspector.

Natural Resources: Title 3, Subtitle 1. Fill and Bulkhead Line; Borrow Limit Line.

This regulation describes a fill and bulkhead line which establishes the westerly limit for bulkheading and filling along the bay side of Ocean City. It also establishes a borrow area limit line which sets a western limit for borrow areas for filling along Ocean City. This regulation has been effectively superseded by the State Wetlands Act.

Natural Resources: Title 3, Subtitle 1. Construction along Shorelines. This regulation creates a Worcester County Shoreline Commission and gives it authority to establish construction standards and issue permits for construction along all shorelines of Worcester County except the Atlantic Ocean. It defines and establishes separate permit conditions for major construction and minor construction. Major construction is defined as any construction that involves 1) any work done more than six feet channelward of mean high water; 2) any fill of more than five cubic yards placed channelward of mean high water; and 3) any digging or excavation involving an alteration of the shoreline. Minor construction is defined as all other construction done along a shoreline. The Shoreline Commission has developed minimum design standards for placement of rip-rap, piers, and bulkheads.

Zoning and Subdivision Control.

The Worcester County zoning regulations include the establishment of a floodplain district which is similiar to but less detailed than the Floodplain Management provisions under the Building Regulations portion of the code. The zoning regulations also include a conservation district for the protection of areas unsuitable for development and in which development would have a significant adverse effect on the natural environment. The current zoning map designates a smaller portion of the wetlands along Isle of Wight and Assawoman Bays as a Conservation District than is recommended in the Comprehensive Plan.

Worcester County Comprehensive Plan.

The Worcester County Comprehensive Plan was prepared in 1976. In contrast with the Ocean City Comprehensive Plan, it specifically recognizes a need to preserve much of the remaining wetlands and stream valleys within the County. The Plan recommends that most of the land fronting Isle of Wight and Assawoman Bays be designated as a Conservation Zone. The Worcester County Comprehensive Plan does not make detailed recommendations

for Ocean City, but recognizes it a highly developed area, and encourages Worcester County to support Ocean City's plans for continued growth and more intense development.

PROTECTING PEOPLE

As a highly developed and very popular coastal resort, Ocean City's population varies seasonally. The estimated average daily residential and transient population ranges from about 11,500 during January to as high as 232,000 during August (see Table 7). An even higher population may occur on weekends during June through September. Holiday weekend populations during the summer of 1983 were reported to have exceeded 300,000. In contrast, the year-round resident population is estimated at about 5,700 (1982). Although the permanent population is low, it also has been increasing in the last few years, partially as a result of retirees moving to the City.

The requirements for providing for the safety of Ocean City's population varies with the season, and depends upon both the number of people present and the type of storm that may occur. Unfortunately, the season of highest population largely coincides with the hurricane season. The hurricane season lasts from June through November and the greatest risk of a hurricane occurs August through October. Although the population drops dramatically after September, an average daily population of more than 50,000 is still in Ocean City during October. The high winds, high water levels and waves created by hurricanes can cause flooding, erosion, extensive property damage, and injury or death to those exposed to the storm. Since all of Ocean City is subject to high winds, and most of the city will be subject to flooding, it is not advisable for anyone to remain in Ocean City whenever hurricane force winds are forecast.

During the late fall, winter and spring, northeastern storms --such as the March 1962 storm -- pose the greatest risk. Although these storms pose less threat than a large hurricane, hurricane force winds (74 mph) can be reached during a northeaster. In addition, they usually last

Table 7. Estimated Average Daily Resident and Transient Population (000).

	1978	1979	1980	1981
January	20.8	12.0	13.1	11.5
February	18.1	12.5	23.1	13.1
March	22.6	26.6	29.8	21.9
April	24.6	27.6	33.8	43.8
May	53.7	58.7	69.9	74.4
June	87.3	119.0	134.4	158.7
July	141.0	161.9	196.9	205.1
August	152.8	173.7	199.7	232.3
September	71.3	99.7	103.2	123.2
October	23.2	31.8	45.8	53.8
November	19.8	22.8	25.8	41.8
December	11.8	11.5	14.8	24.8
Monthly Average	53.9	63.2	74.2	83.7

Source: Ocean City Health Services

longer than a hurricane (up to six tidal cycles), and the long period of high water and heavy wave action can cause severe erosion and extensive flooding. Population levels are much lower during these months of the year, but there are still a sufficiently large number of people in Ocean City to cause evacuation concerns.

It has been more than 20 years since Ocean City was affected by a major storm. During the March 1962 storm, tides were nine feet above mean low water, parts of Ocean City were completely underwater, and several feet of sand were deposited on streets and lots. Although many buildings in Ocean City were destroyed or severely damaged, the efforts of civil preparedness, police, volunteer firemen and other volunteers were credited with providing emergency warnings for evacuation or safe shelter and for rescuing those who required assistance.

Today Ocean City is well aware of the potential for another damaging storm similar to the 1962 northeaster or for an even more damaging hurricane. City officials have expressed their belief that Ocean City is well prepared to provide sufficient warnings, evacuate people if necessary, and survive the storm just as they did in 1962. These views are based on the existence of an "Ocean City Emergency Operations Plan" and confidence in those City employees and volunteers who would assist in implementing the plan.

City officials have also expressed their concern about overemphasizing hurricane prepardness and evacuation warnings. They are concerned that future development and tourism could be adversely affected if too prominent attention is given to the hurricane hazard. They are also concerned about providing evacuation notices that turn out to be unnecessary because the track or intensity of a hurricane changed or was not accurately forecast.

The current "Ocean City Emergency Operations Plan" was developed several years ago (the plan is undated). The plan provides a detailed breakdown of individual and department responsibilities, available equipment, coordination with County and State emergency management agencies, and which of the three potential evacuation routes should be used by different geographic areas within Ocean City. The local Civil Preparedness Director indicated that the plan is reviewed annually and updated as needed, and that table-top exercises are also held periodically. However, local and State civil preparedness officials indicated that no field exercices have been conducted to test community preparedness and the effectiveness of the plan. The city is reportedly planning to hold a field exercise in 1984.

The Emergency Opertions Plan does not address several important issues, including: special evacuation needs of certain segments of the population, such as the elderly, handicaped, and families of emergency workers; time required to evacuate Ocean City given different levels of population present; designation of available emergency shelters for non-residents; and the location and relative time at which one or more of the evacuation routes may become impassable due to flooding. Since the plan is not dated and updates are not indicated or dated, it appears impossible for City officials to know if they have the most up-to-date version of the emergency operations plan. Information regarding the evacuation routes and other key elements of the plan do not appear to have been made available to most residents and property owners. At least one condominum -- the Sea Watch Condominum -- has developed a simple set of hurricane procedures for owners, renters and staff to follow. However, emergency hurricane procedures are apparently not provided by most motels and condominums.

The Maryland Emergency Management and Civil Defense Agency, through the State office in Pikesville and the Worcester County office in Snow

Hill, provides support and coordination with Ocean City emergency procedures. The State and County organizations are responsible for mobilization of public and private resources to save lives, limit damages, and speed recovery in emergencies and disasters. Their emphasis is on planning, training and exercises designed to achieve operational readiness.

A Storm Evacuation Planning Map was released in June 1983 that includes the Ocean City area. This map was prepared by the National Ocean Survey in cooperation with the Maryland Emergency Management and Civil Defense Agency. It is intended to be used by agencies responsible for evacuation to assist them in planning detailed evacuation routes and procedures. The map identifies the key evacuation routes in the Ocean City/Fenwick Island area, spot elevations on major evacuation routes, flood zones, summer and winter populations of major communities, and the location of storm evacuation shelters.

CONCLUSIONS

Ocean City today is more vulnerable to losses from a major hurricane or northeaster than at any time in the past. Some of the major reasons for this increased vulnerability are highlighted below.

The tremendous growth of Ocean City since the late 1960's has greatly increased the amount and value of property subject to damage from flooding, erosion, and high winds. Similarly, the number of people in Ocean City at all seasons of the year has greatly increased, compounding the potential problems of evacuation and safe refuge from a storm.

The present narrow width of the beach between Mean High Water and the Building Limit Line combined with the total or partial destruction of most of the natural dune line, leaves Ocean City with very limited protection from storm waves and overwash -- subject to damage from storms with a five-year return frequency or greater.

The current program of groin placement -- if implemented according to approved plans -- will provide only for 10-year storm protection when completed in 25 years. This groin placement program will be more useful for maintaining a viable recreational beach than for providing increased storm protection. Currently, the groins are being constructed without sand fill and, consequently, they will have little or no effect on increased storm protection or improved recreational beach.

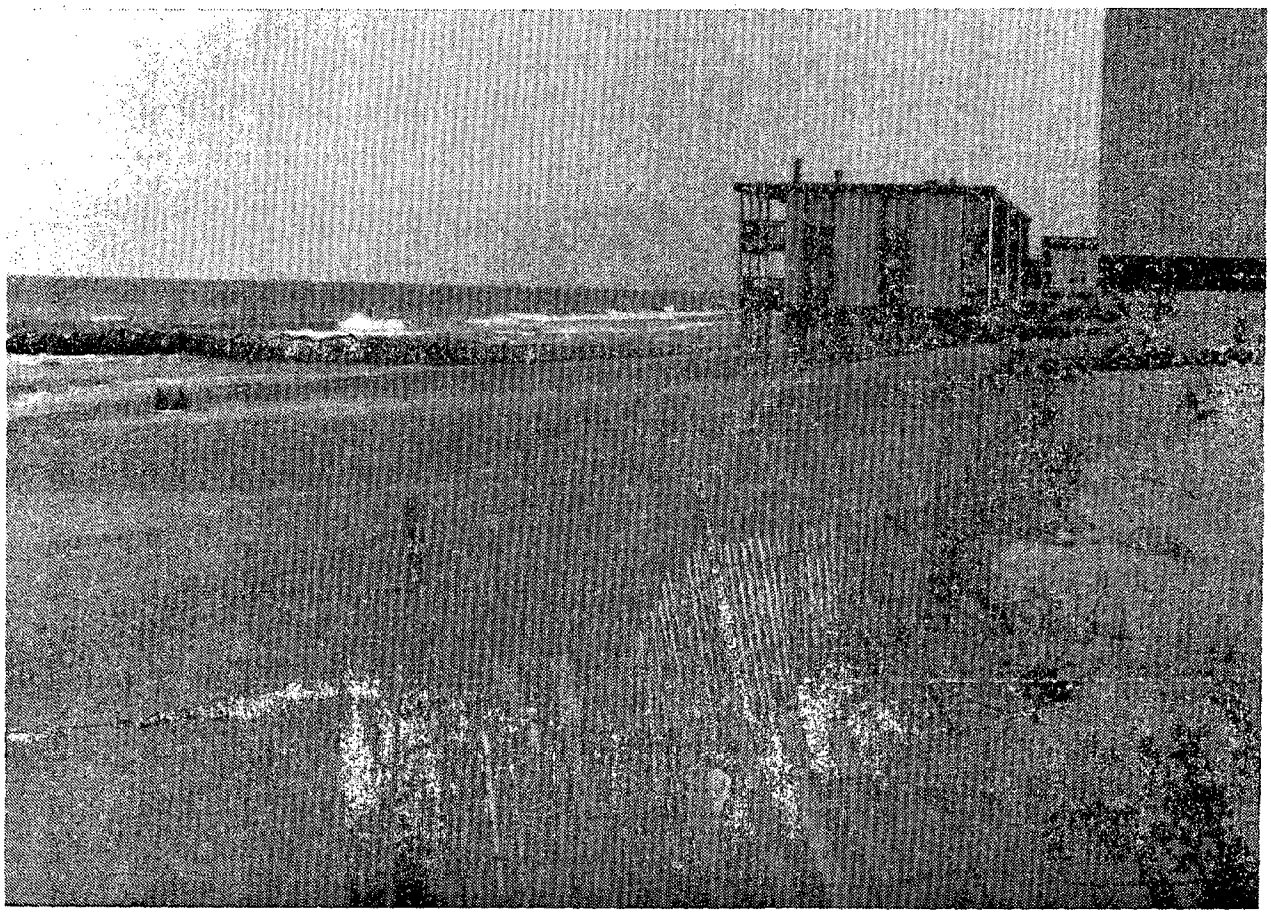
The practice in recent years of bulldozing sand from the lower beach to form temporary berms may actually result in increased rates of erosion, and cause long-term costs which outweigh any short-term economic or storm protection benefits.

Current efforts to properly restore or create dunes will increase the amount of storm protection provided. However, unless the width of the beach is increased, the dunes will be subject to destruction by storms with a 50-year return frequency or greater.

The State, County and City have developed and implemented several regulations and programs that have positive flood loss reduction benefits. However, these regulatory measures often do not fully recognize the extremely vulnerable nature of Ocean City as a coastal barrier subject to both change and movement as a result of long-term natural forces and short-term storm events. Some of the current regulations are inadequate to deal with the flood and erosion potential of a developed coastal barrier; some of the regulations are out-of-date; some regulations appear to conflict with one another; some basic regulatory requirements are not in effect; and enforcement of some regulations appears not to have been uniform over the years.

Partially as a result of having survived the 1962 Ash Wednesday storm, many Ocean City officials, residents and property owners appear unduly optimistic regarding their ability to come through a major hurricane relatively unscathed. This optimistic view is compounded by concerns that too much emphasis on hurricane preparedness will result in a possible decrease in future development and tourism. Consequently, insufficient attention has been given to hurricane warning and preparedness measures and dissimenation of information to the public.

BEFORE THE STORM:



REDUCING DAMAGE POTENTIAL

Ocean City is faced with understanding the current status of their flood hazard vulnerability and potential damages that could result from a 10-, 50-, or 100-year storm event. Short-term responses which may provide for a better beach for bathers next summer or individual dune stabilization efforts which may protect one or several structures are not enough. A comprehensive hazard mitigation strategy must be implemented before a storm occurs to reduce the damage potential across the entire city. In addition, the actions taken now will serve as a basis for guiding redevelopment after a storm occurs.

This section provides an analysis of four storm and beach protection plans regarding their effectiveness and their costs and benefits as structural (beach erosion and flood control) measures. The implications of implementing any of the structural measures with other proposed nonstructural techniques are discussed. Finally, a number of nonstructural (land use control) techniques available to the city and state are compared with other coastal states and communities.

ANALYSIS OF STORM AND BEACH PROTECTION PLANS

The northeast storm of March 1962 created a need for emergency storm and beach protection efforts by the U.S. Army Corps of Engineers, but a longer term solution was and is still needed. Four storm and beach protection plans that address beach erosion and flood control in varying degrees, are currently being considered by federal, state and city officials for Ocean City, Maryland. They all are considered structural solutions because they keep the water away from the people. They include the following:

1. "Hurricane Protection and Beach Restoration Plan" prepared by the U.S. Army Corps of Engineers, Baltimore District, and described in Atlantic Coast of Maryland and Assateague Island, Virginia - Feasibility Report and Final Environmental Impact Statement, revised August 1980;.

2. "Interim Beach Maintenance at Ocean City" plan prepared by Trident Engineering Associates, Inc. and described in The Trident Report On Interim Beach Maintenance at Ocean City, October 1979;

3. "Hybrid Plan" prepared by the Coastal Resources Division, Department of Natural Resources, Tidewater Administration which combines features of the Corps and Trident plans; and,

4. "Groin Location Plan for Interim Beach Maintenance" jointly agreed upon by the state and city in April 1982 and recently revised, referred hereafter as the status quo.

The primary approach in analyzing the effectiveness and cost/benefit of these plans focuses on the short-term and long-term value of these structural alternatives. Beyond the specific differences in design characteristics and storm-frequency protection, the time required to complete the plans is important because changes in the natural and built environments will continue to occur. The impact of sealevel rise is considered in a general manner to emphasize more dramatically the importance of long-term hazard mitigation planning on a developed barrier beach.

EFFECTIVENESS

The effectiveness of each beach protection plan varies with respect to its erosion and flood control functions. To make a qualitative evaluation of each plan's effectiveness, seven basic design characteristics were assessed. The characteristics included: (1) beach width; (2) berm width; (3) berm height; (4) dune width; (5) dune height; (6) bulkhead height; and, (7) nonstructural measures. For purposes of this discussion, those characteristics relating to a horizontal dimension (nos. 1, 2 and 4) are considered to provide for erosion control and those relating to a vertical dimension (nos. 3, 5 and 6) are considered to provide for flood control. The erosion and flood control functions of beaches and dunes are not mutually exclusive as one might infer by this separate consideration of the horizontal and vertical dimensions. This is simply one way of comparing effectiveness. Two other aspects considered in the evaluation of effectiveness include the length of time required to complete the plan and the long-term effectiveness. Table 8 summarizes the basic information used for evaluating the four plans.

Table 8. Summary of Basic Design Characteristics of the Four Current Beach and Storm Protection Plans for Ocean City, Maryland

Plans	EROSION AND FLOOD CONTROL CHARACTERISTICS						STORM PROTECTION (frequency event in years)	Work Schedule
	Beach Width	Berm		Dune		Bulkhead Height		
		Width	Height[1]	Crest Width	Height			
1. "Hurricane Protection and Beach Restoration Plan" (Plan 3) Corps of Engineers August 1980	200'	135'	8.7'	25'	16'	16'	100	10 years to complete
				extends from 27th St. to State Boundary		extends from N. Division St. to 27th St.		
2. "Interim Beach Maintenance at Ocean City" Trident Engineering Associates, Inc. October 1979	170'	90'	8.7'	-	-	-	8	47 short groins with sand fill over 5 years
3. Hybrid Plan (1&2) DNR-Coastal Resources Division	170'	90'	8.7'	25'	16'	16'	100	10 years to construct groins dunes and bulkhead
				extensions same as Corps Plan				
4. Status Quo Yearly Allocation from State	170'	90'	8.7'	-	-	-	<10	2 short groins per year for 25 years

[1] Referenced to National Geodetic Vertical Datum (NGVD).

General Assessment

All four large scale plans, emergency bulldozing and individual efforts to stabilize dunes are actions which emphasize the public desire to stabilize Fenwick Island. The long-term committment of these actions has different implications regarding man's desire to stabilize and fight nature versus nature's power to move the barrier regardless of what man does. The long-term value and effectiveness of bulldozing and constructing discontinuous dunes is that they can be implemented at any position the shoreline takes. They will only provide protection for particular areas and only during high frequency storm events (less than 10-year event).

The Corps and hybrid plans have the most effective design for both erosion and flood control. They both incorporate dunes and bulkheads and are expected to offer protection against the 100-year frequency storm event. Both plans are estimated to take ten years to complete and as more time passes, more sand will be needed to comply with the plans. The actual construction procedures have not been established, but it is assumed that sections of beach and dune would be completed in order to provide both erosion and flood control for each section of shoreline. A major difference between these two plans would be the order in which sections are completed. Construction of groins in the hybrid plan requires the sections to be completed in order from south to north. This would leave sections in north Ocean City vulnerable until project completion. The Corps plan, however, seems to have more flexibility whereby lower, more vulnerable sections of beach could be constructed on a priority basis. Also, a proposed warning and evacuation plan associated with the Corps plan addresses an additional flood hazard mitigation concern. The warning and evacuation plan could be designed to complement the beach and dune construction plan so that short-term, nonstructural protection is provided to those sections not completed during the ten year period.

The Trident and status quo plans are comparable in that they are designed to provide only limited and interim erosion control. Neither plan proposes dune or bulkhead construction and only offer protection against the 8- to 10-year frequency storm event. Both plans incorporate the installation of groins; however, the major difference lies with the length of time required to complete each plan. The estimated five year construction period for the Trident plan makes it more effective than the 25 year period estimated for the status quo plan. Beach areas toward the north end of Ocean City would continue to have an uncontrolled erosion problem until the status quo plan is completed. No additional nonstructural measures are proposed for either plan, other than flood insurance which is currently available.

Specific Evaluation

In all plans, except for the Corps plan, groins are a primary feature. The long-term performance record of groins, in the United States has generally not been good. Several problems which can result include: interruption of the littoral drift; loss of sediment offshore as it passes around the outer ends of the groins and shifting of erosion problem down drift (Leatherman, 1982); complication of erosion and accretion patterns (pers. comm. Steve Gabriel, Public Works, Ocean City, New Jersey 7/11/83) and a hazard to swimmers and bathers. Some groins have satisfied their intended purpose, but most have been either ineffective or have had detrimental effects (Leatherman, 1982). The effectiveness of existing groins in Ocean City has not been quantitatively determined, but qualitatively they have been considered ineffective because they are too short and spaced too far apart (Trident, 1979). While filling each groin cell with sand is considered a primary requirement to assist in avoiding the negative impacts of groins, a borrow site for sand in the initial phase of the status quo plan between 7th and 9th Streets has not yet been agreed upon by the

City. Groins will not help to build a beach higher than what would occur without them. They may, however, keep sand in a particular location for a longer period of time. In the short-term, less replenishment would be required in an area with groins provided the cell was filled to capacity.

Groins will not respond to natural changes in the beach position or offshore slopes. Groins will have their best results if they are positioned properly with respect to Mean Low Water, if they are properly spaced apart, if they have a bedding material, if they are wide and long enough and if they are filled to capacity with sand. This is certainly a long list of conditions. In reality, removal of beach fill between the groins during erosional storm processes will expose the groins and result in downdrift erosion. Although some trapping of sand will occur on one side of a groin (updrift), erosion and sand deprivation probably will occur on the other side (downdrift). The Trident and status quo plans are short-term or interim plans in the first place. They are not expected to have long-term effectiveness. The incorporation of a dune line in the hybrid plan gives it more long-term value; however, the groins would detract from the overall value. As beach geometry changes, the relationship with respect to the groin position and design will also change. Groins may accelerate erosion in one location or transfer it to a number of others. What is certain is that a beach will no longer change and adjust to natural conditions after groins are constructed.

The Corps plan, or one like it, has the greatest long-term value and effectiveness because of its ability to fluctuate and move in response to gradual and immediate changes in beach form and offshore slopes. The transport of sand along the beach environment will not be impeded by shoreline structures such as groins. The relative position between the beach and dune must remain fairly constant, but it can shift seaward or landward and not lose any of its ability to provide erosion and flood

control. The maintenance requirement for sand replenishment a continual basis, will be no higher than that for the groin plan. Only the frequency of nourishment could be higher.

Sea Level Rise Considerations

The preceding discussion of beach nourishment activities assumed that sea level will follow its previous trend. However, an Environmental Protection Agency report (Titus, et al, 1983) has been released that projects a substantial rise in sea level resulting from emissions of carbon dioxide, methane, nitrous oxide, and fluorocarbons. Increasing concentrations of these gases are expected to produce a global warning which could cause ocean water to expand and glaciers in Greenland and Antarctica to melt. The EPA report projects a rise in sea level of one-half to over two feet by the year 2025, and two to ten feet by 2100.

Without additional beach nourishment activities, such a rise in sea level could cause several hundred feet of erosion. Of the projects under consideration, only sand replenishment is likely to effectively preserve the barrier form. Directly or indirectly, it would be necessary to raise the entire beach profile and barrier elevation by the amount of sea level rise. Assuming that the closure point, or critical change in nearshore slope, is 1500 feet from dune line a 1-1/2 foot rise in sea level implied by EPA's medium scenario would require approximately 3.5 million cubic yards of sand along the eight miles of shoreline by 2025, in addition to the quantity required by programs to address erosion that has occurred in the past.

The prospect of accelerating erosion and increased flooding from sea level rise could also have important consequences for post-disaster planning. In the absence of a major disaster, Ocean City may prefer to wait for better projections of sea level rise, which should be forthcoming in the next decade. However, because of the substantial

amount of resources involved in the rebuilding phase, the private sector would need a clear signal of the City's anticipated response to sea level rise in the following decades.

Most importantly, Ocean City would have to explicitly decide whether its policy would be to maintain the 1980 (year?) shoreline regardless of cost, or whether there is an upper limit to the annual sand replenishment that the City is willing to consider. In the latter case, ocean front property owners considering reconstruction of severely damaged houses would want to consider whether future erosion would be likely to cause increased risks and insurance premiums in the future; and the City would want to consider whether the benefits of rebuilding damaged structures would be worth the price of the future public beach being cluttered with houses. If not, additional set back requirements might be necessary.

COSTS AND BENEFITS

The costs and benefits (in dollars) for each of the four plans are not completely documented. Cost estimates exist for all four plans but, unfortunately, benefit estimates only exist for the Corps plan. Existing cost estimates have been made over a three year period (1979-1982) and changes in construction costs (material and labor), inflation and interest rates make direct and quantitative comparisons difficult. The Corps and Hybrid plans have estimated costs which exceed the Trident and status quo plans primarily because of the added costs associated with dune and bulkhead construction. Groin construction costs for the hybrid plan make it the most expensive initially; however, annual beach maintenance costs are expected to be lower if the groins successfully trap sand as they are designed. As previously discussed cost overruns may also contribute to any groin plan. Other factors not considered, but which are admittedly difficult to assess and derive a

long-term cost, are the maintenance of the groins themselves and the lack of eligibility for disaster funding following a presidentially declared disaster, as was the case with the 1962 post-storm federal disaster assistance efforts. Another disadvantage to the use of groins relates to their ineligibility for credit towards any federally funded restoration project. Since groins are not part of the proposed Corps plan, no funds will be reimbursed to the City or State if and when the federal plan is approved and authorized, as stated earlier.

Costs associated with the status quo plan should be expected to be higher than those for the Trident plan because of the up to 20 year separation in completion dates (and an expected increase in costs). It appears that the Trident plan would have the lowest costs of the four plans but a selection based solely on this criterion would be shortsighted. Costs of any plan should be balanced with longer term erosion and flood control benefits that are provided.

The average annual benefits of the Corps plan have been estimated to be 2.4 times greater than its average annual costs. This is fairly high for a Corps project. But the benefit to Ocean City is primarily recreational and, thus, the plan has a low priority status for Corps approval. No benefit/cost ratio exists for the Trident, hybrid or status quo plans which precludes any comparison of plans in terms of their dollar value. Qualitatively, the primary benefit for all four plans is recreational with additional hurricane protection (flood control) provided by the Corps and hybrid plans. Any benefit analysis for these two plans would account for damage reduction to structures utilities and lives as a result of the protection provided by dunes and bulkheads. Since the primary benefit of the Trident and status quo plans is erosion control, a benefit analysis is primarily confined to evaluating the day usage during the summer months (i.e., recreational value).

One of the major benefits of a plan that incorporates groins is that it provides a way in which the State and City can begin working in a cooperative effort to decrease hazard vulnerability in Ocean City with at least some plan. Selection and use of a sand source for beach restoration and cost-sharing arrangements can thus be expedited.
An advantage to having a beach restoration plan of any kind is that federal reimbursement of sand lost during a presidentially declared emergency or disaster is possible. Without any committment to beach restoration, the beach does not become a public facility and will not be eligible for disaster funding.

Benefits based solely on sand dynamics lie with any plan which is least dependent on shoreline protection structures. Complicated patterns of erosion and accretion changing relationships between depth, length and height of groins and beachface slope, width and height will be avoided. Ocean City now has the benefit of not relying on shoreline structures or being financially committed to them.

As Ocean City continues to grow as a recreational facility, pressures will increase to maintain a recreational beach. However, growth of the community is also translated in numbers of structures, extent of infrastructure and possible damages that can result from storms. The benefit of a hurricane protection plan will have higher value over time because of the increased investment relating to the recreational benefits. Estimated storm damages four years ago as compared to those in 37 years without hurricane protection increased substantially as noted below (COE, 1980):

Storm Frequency	10-year	20-year	50-year	100-year
1979	$2.9 million	5.3	32.9	50.8
2020	6.4	8.4	39.1	73.7

General Deficiencies

The City and State do not have the benefit of considering a protection plan designed for a moderate frequency storm (i.e., the 20- or 50-year event). Creation of a new plan which either upgrades an interim beach protection plan or downgrades a long-term flood control plan would be advantageous. Recognizing that plans often provide less protection than that for which they were designed, Ocean City must avoid the downgrading of the status quo plan where they may only equal the protection they now have. By not filling the groin cells to capacity for example, Ocean City would basically retain the beach they now have, providing no adverse impacts occurred (i.e., downdrift erosion). If the City and State seek 100-year design protection and only achieve 50-year protection, then they will still be improving upon the existing level of production.

Nor do any plans have nonstructural measures associated with them. The Corps plan acknowledges the need for warning and evacuation, but no details are provided in the report. Incorporating higher building code standards, new zoning by-laws, acquisition strategies or any means of removing damageable resources from the threat of floods along with a beach restoration plan will reduce the potential costs of damage.

IMPLEMENTATION WITH NONSTRUCTURAL MEASURES

The four structural storm and beach protection plans are receiving priority attention and justifiably so. Shoreline erosion has continued

to be unimpeded while ocean-front development has remained in a static position and increased in density. The first line of defense obviously lies with improvement of the beach and dune resources. But while the immediate concern is beach erosion and current efforts are directed towards short-term interim protection (i.e., for the 10-year storm), protection against flooding during a lower frequency storm (i.e., 20-, 50- or 100-year) should receive concurrent attention.

The nonstructural mitigation alternatives which include elevation requirements, construction setbacks, land acquisition, building code improvements and evacuation will fulfill a more comprehensive flood hazard mitigation strategy when combined with any of the structural storm and beach protection plans. The implementation of particular measures and the specific standards associated with them is related to the type of beach protection plan that is selected. If a 10-year protection plan is implemented and a 100-year storm occurs, the need for a greater number of flood mitigation measures and standards to reduce damages is higher than that associated with a 100-year protection plan that's in place when a 10-year storm occurs. Table 9 is used to better describe the relationship.

Table 9. Implementation of the Storm and Beach Protection Plans and the Necessity for Nonstructural Flood Hazard Mitigation Measures.

Storm Frequency	10-year	50-year	100-year
Plan			
Corps	Low	Low	Moderate
Hybrid	Low	Moderate	High
Trident	Moderate	High	High
Status Quo	High	High	High

The low necessity for incorporating nonstructural measures with the Corps and Hybrid plans is due to the fact that dunes will protect against substantial flooding. The moderate necessity for additional measures with these plans is due to the increased vulnerability to bayside flooding (not mitigated by oceanfront dunes) and increased vulnerability with reduced beach protection over time. The groins in the Hybrid plan make the latter factor more significant than in the Corps plan. The beach and dunes will simply not be permitted to fluctuate and adapt to long-term changes. The necessity for more nonstructural measures, then becomes an even higher concern for protection against the 100-year storm as time goes on.

The time required for implementation is the only factor which distinguishes the difference between a moderate necessity for 10-year protection by the Trident plan and a high necessity for 10-year protection by the status quo. At least widespread erosion protection will be offered in a relatively short period of time with the Trident plan versus a very limited number of areas that will be protected until the status quo plan is completed (up to 25 years). Because each plan is designed for short-term erosion control during storms greater than the 10-year frequency, the necessity for implementing nonstructural flood hazard mitigation measures is high if the City and State desire a reduction in damage potential.

COMPARISON WITH OTHER COASTAL STATES AND COMMUNITIES

The State and local regulations that currently govern Ocean City and the coastal portions of Worcester County generally provide at least a minimum protection from flood hazards when compared with national standards and the regulations prevalent throughout coastal communities. In some cases, the regulations affecting the Ocean City area go beyond minimum standards. In other instances, minimum standards are absent.

Many coastal states and communities have concluded that they prefer more than minimum protection. Often the decision to adopt flood protection requirements that are more stringent than required or in common practice has come after a community sustained severe damage from a hurricane or northeaster. This section looks at some of the actions other coastal states and communities have taken to see how they compare to the existing requirements affecting the Ocean City area.

Elevation Requirements.

FIA minimum requirements for community participation in the National Flood Insurance Program require that structures within the designated V-zone be elevated to or above the 100-year flood level -- including wave height, if wave heights have been determined. Prior to May 1983, wave heights had not been determined in Ocean City, and the elevation requirement in V-zones was to or above the still-water elevation. Since issuance of the new maps, structures must be elevated to or above the wave height elevation.

Several communities recognized that the FEMA methodology for determining coastal flood elevations for V-zones was limited if it did not include wave heights, because other factors cannot be accurately modeled or measured, and because of the limited detail in which the flood insurance

studies are performed. Consequently, these communities required the lowest floor of buildings in the V-zone to be elevated from one to five feet or more above the FEMA determined V-zone elevation (e.g., Southhampton, NY, East Providence, RI, Wrightsville Beach, NC, and Scituate, MA (Kusler, 1982)). Even when wave height were included in the flood insurance study, some jurisdictions have required more that the minimum elevation. for example, the State of Connecticut amended its state building code in 1981 to require any structures within the V-zone to be elevated above the 100-year flood level with wave heights. Among Connecticut's reasons for establishing this requirement was to provide for a margin of error in the flood insurance studies and to allow sufficient freeboard for the passage of wave-tossed debris without damaging the structure.

Requirements for buildings to be raised above the minimum elevation requirements in A-zones is less common. The potential for damage in A-zones is much less than in V-zones if flood waters exceed the 100-year regulatory standard. Ocean City's current regulations require the lowest floor to be elevated to 10.5 feet above mean low water (9.3 feet NGVD). This required elevation exceeds the designated A-zone elevations which range from 6.0 to 9.0 feet NGVD.

Setbacks.

Setbacks are a common regulatory method used by coastal states and communities to protect their beaches, dunes, wetlands and shorefront development. Some setback regulations, such as those adopted by the State of Florida (FEMA, 1982), require a special permit or variance in order for a structure to be located within the setback line, while others prohibit construction within the setback line. Setbacks may be intended to protect structures from flooding or from erosion, and may also be intended to preserve natural features such as sand dunes and wetlands. North Carolina has established setbacks for three critical areas: areas of rapid erosion; areas where inlets may form or inlets are known to shift; and areas

of estuarine shoreline concern (McElyea, 1982).

The setback distance can be determined based on several factors, but two common criteria used in oceanfront areas are the landward extent of the FEMA designated V-zone (e.g. Panama City Beach, FL) and the landward edge of the primary dune (e.g. Wrightsville Beach, NC (Kusler, 1982) and Jekell Island, GA (Univ. of Georgia, 1983)). In areas of severe erosion some communities (e.g. San Diego, CA (Kusler, 1982)) have adopted a setback distance sufficient to protect the structure for its expected life. If erosion averaged 2.5 feet per year and a structure was expected to last 100 years, the setback requirement would be 250 feet. A similar requirement is to establish a setback keyed to the financial investment in the structure (State of Michigan), e.g. an assumed 30-year life based on the length of the average home mortgage in an area with 2.5 feet of erosion per year would require a structure to have a 75 foot setback.

Setbacks are provided in at least two ways. A special local ordinance or a state legislative act or regulation may establish the setback throughout a jurisdiction based on a uniform fixed distance from a natural feature such as mean sea level, primary dune, or edge of wetlands, or establish a more variable line based on other criteria such as the landward extent of the V-zone. In other cases, local zoning regulations may establish setbacks that vary depending upon the permitted land use.

The State-Ocean City Building Limit Line is a State legislative act that provides for a setback of structures from the ocean in Ocean City. The primary purpose when this line was established was to prevent buildings from being constructed on the beach with a resultant loss of recreational use of the beach. The Building Limit Line was not established specifically to protect property from damage or to protect sand dunes from destruction. In fact, the BLL is delineated so that it falls on the natural dune line and in many cases seaward of the natural dune line. Ocean City

zoning regulations permit the construction of buildings up to the edge of the Building Limit Line.

There are currently no uniform setback requirements from wetlands in Ocean City and Worcester County. State regulations governing wetlands provide for a case-by-case determination of whether construction will be permitted in wetlands. Worcester County zoning regulations provide for some wetland areas to be set aside as conservation and open space areas, but establish no setback requirements in other wetland areas. Ocean City zoning regulations do not require a setback from wetlands.

Dune Protection and Restoration.

Setback requirements are often combined with programs and regulations designed to maintain and restore the natural dune line. Dune protection and restoration through the use of sand fencing and dune vegetation is practiced by numerous communities as a means of reducing the impact of storm surge. For example, the town of Avalon, NJ embarked on a successful dune restoration program after suffering damages in the same March 1962 storm that affected Ocean City (Farrell, 1983). Many communities require that walkways be constructed over dunes to prevent their destruction by pedestrian traffic.

Ocean City does have regulations (Sectin 46. Erosion and Sediment Control) intended to protect or restore dunes. However, these regulations permit the removal of an existing natural dune if an artificial dune and berm are developed seaward of new structures. This results in the dune being moved closer to mean high water and subject to rapid destruction during storms. In addition, lack of enforcement of dune maintenance requirements has resulted in the gradual elimination of most protective dunes in Ocean City. The net effect of the State-Ocean City Building Limit Line and the Ocean City Erosion and Sediment Control regulations is to virtually assure that a protective dune line cannot be maintained in Ocean City.

Acquisition of Hazardous Areas.

Following the March 1962 storm, Avalon and Sea Isle, NJ acquired several storm damaged properties using funds provided by the State of New Jersey Green Acres program (Kusler, 1982). Other communities such as Scituate, MA and Gulf Shores, AL have used federal funds[1] in recent years to acquire flood damaged properties following a major disaster. Other communities use their zoning or subdivision regulations to require developers to set aside or dedicate to the town hazardous areas that are part of their development. This technique has been used in Clearwater, FL to require 10% of the area of a subdivision to be set aside for public use.

In Ocean City, the State of Maryland has acquired over 50 separate small parcels under the provisions of the Beach Erosion Control District Act. Acquisition occurred when the property owners were denied permits for building because the location of the Building Limit Line rendered their lots too small to meet zoning requirements. Additional lots may be acquired by the State under this Act. Ocean City has acquired numerous easements of beachfront property. Although the areas where most of these easements were acquired were seaward of the Building Limit Line and could not be built on, public easements ensure that the beach area will be accessible for recreational use.

Construction Standards.

Many states have adopted uniform building code requirements that apply

---

[1]These properties were acquired using the provisions of Section 1362 of the Natinal Flood Insurance Act. Under this program, FEMA may acquire eligible properties and transfer the property to a state or local government that agrees to maintain the property in an open space or recreational use. To be eligible for acquisition under this program, several criteria must be met, including: the property was damaged 50% or more of market value in a single flood, or damaged 25% or more three times in five years; property must be covered by flood insurance; and the property owner must voluntarily sell the property -- condemnation is not permitted.

to all communities within their state. In the eastern United States the two most commonly adopted building codes are the Standard Building Code developed by the Southern Building Code Congress, and the BOCA Code developed by the Building Officials Code Administrators. These standard codes may be adopted in whole or in part, and portions may be modified or supplemented to meet specific state standards. In states where a uniform state code has not been adopted, many communities have also adopted the Standard or BOCA codes, with appropriated modifications. These building codes contain both specific and performance standards covering most types of construction. Both of the codes mentioned above include standards for construction in floodplains and coastal areas. States and coastal communities rely on these codes and the certification of a professional engineer or architect to ensure that all buildings in coastal flood hazard areas are properly constructed to withstand the expected forces of wind, waves and floodwaters. For the most part, these codes do not contain specific standards for construction in coastal high hazard areas or for floodproofing of buildings. Instead, they rely on performance standards that are subject to varying interpretation by the engineers and architects responsible for design and construction. Unfortunately, few engineers and architects have been trained in the proper techniques for construction and floodproofing in coastal flood hazard areas. Likewise, few building inspectors have received training in construction and floodproofing in coastal flood hazard areas, and do not have the specialized knowledge to judge the adequacy of the design proposed by an engineer or architect.

In addition to building codes, communities participating in the National Flood Insurance Program must also establish minimum standards for elevation (discussed earlier in this section) and floodproofing. The minimum standards for floodproofing recommended by FEMA are adopted by almost all communities. As with the uniform codes, these regulations specify performance rather than specific standards, and rely on proper design

and choice of construction materials by an architect or engineer.

The loss of hundreds of buildings during coastal storms to the forces of wind, high water levels, wave impact, and erosion, or a combination of these forces are evidence of the inadequacy of most building codes, construction techniques, and code enforcement procedures in coastal high hazard areas. Some of the major problems that have been observed are inadequate connections between the foundation and the upper structure, improperly designed walls that do not permit the passage of floodwaters and waves, failure of bulkheads and seawalls, and failure to sink pilings and other foundations properly and deep enough to withstand general erosion and scour around the foundation.

In response to these problems, some communities, such as Scituate, MA, Gulf Shores, AL, and Sanibel Island, FL, that have suffered major building losses during a coastal storm have enacted supplemental standards to their building codes that provide specific requirements for foundation construction, depth of pilings, foundation bracing, and connections throughout the structure. These specific standards apply mostly to one and two story structures and are largely based on research sponsored by FEMA into proper construction techniques in coastal areas. High-rise buildings are still generally regulated by performance standards, with certification by an architect or engineer. These research results are also resulting in the addition of specific construction and floodproofing standards in some basic building codes. The BOCA code was revised during 1983 to include more specific floodproofing standards for both coastal and non-coastal areas. The Standard Building Code has not yet been revised.

The State of Maryland has not adopted a uniform state building code. Ocean City has adopted the Standard Building Code and the minimum FEMA regulations regarding floodproofing. In addition, Ocean City has exceeded

the minimum standards by the enactment of its Foundation Regulations in Critical Areas. In contrast, Worcester County has not adopted any building code. Worcester County does have the minimum FEMA requirements for floodproofing of buildings in A-zones and V-zones, and has created the Worcester County Shoreline Commission with authority to establish construction standards and issue permits for construction along all shorelines in Worcester County, except the Atlantic Ocean.

Warning and Evacuation.

Even when other measures to reduce flood losses have been taken, it is not safe to remain in vulnerable coastal areas during a major hurricane. In the last few years many coastal communities have become increasingly concerned about their ability to evacuate the people from their communities in the limited time available following issuance of a hurricane warning by the National Weather Service.

Florida, assisted by the National Oceanic and Atmospheric Administration, FEMA, and the Corps of Engineers, has led the nation in the development of detailed, regional hurricane warning and evacuation plans. The first of these plans was prepared for Lee County, Florida in the late 1970's as a pilot project. Subsequently, more detailed and sophisticated plans have been developed for the Tampa Bay region and Lower Southeast Florida. Florida is also developing its own hurricane warning system to supplement the information provided by the National Weather Service so that it can provide Florida communities with additional warning of the probability of a hurricane striking any given area.

Additional regional warning and evacuation plans are underway in other communities on the Gulf and Atlantic coasts. These studies are being funded through the FEMA Hurricane Preparedness program, with contributions from the Corps of Engineers (study costs generally exceed $200,000). These warning and evacuation plans are based on detailed predictions

of coastal innundation during hurricanes using the SLOSH model (this model provides much more detailed information than the standard FEMA Flood Insurance Rate Study and detailed storm history and topographic information must be developed for each area in which the model is applied). The plans develop detailed information on the number and special needs of people that will have to be evacuated from a given area, how local evacuation routes may be shared with other communities, flooding and other problems that may restrict the use of some evacuation routes, and the capacity of the routes to handle the traffic that will be required.

The community of Sanibel, FL (an island off the southwest coast of FL) was sufficiently concerned about its ability to evacuate residents and visitors to the island that it established a cap on growth keyed to its ability to safely evacuate the island within the warning time provided by the National Weather Service. Sanibel subsequently developed a detailed hazard mitigation, hurricane evacuation, and post-disaster recovery plan (Rogers, 1981). Information concerning the hurricane hazard and evacuation procedures receive prominent attention. Each summer a detailed description of hurricane preparedness measures and local evacuation procedures, including maps of evacuation zones and maps, are published as a special supplement in a local newspaper.

Ocean City has developed only a minimum flood warning and evacuation plan that appears inadequate given the vulnerable nature of Ocean City, limited egress from the barrier, and the very large number of people that may be in Ocean City during the hurricane season. Information concerning the hurricane hazard and warning and evacuation procedures have received limited public distribution.

CONCLUSIONS AND RECOMMENDATIONS

STRUCTURAL MEASURES

The most effective erosion and flood control plan for Ocean City on a long-term basis appears to be the Corps of Engineers' "Hurricane Protection and Beach Restoration Plan" based on its level of protection, time of implementation, long-term ability to endure and ability to adapt to shoreline changes and study justification (benefit/cost ratio).

Any erosion and flood control plan that incorporates the use of groins will require a higher degree of shoreline stability to be effective on a long-term basis.

Groins will have their best results if:

- They are positioned properly with respect to mean low water;
- They are built sequentially from South to North
- They are properly spaced apart;
- They have a bedding material;
- They are wide and long enough;
- They are filled to capacity with sand; and
- Everyone realizes they will only provide interim or short-term, 10-year storm protection.

No detailed benefit/cost analyses exist for any erosional and flood control plan other than the Corps plan; therefore, a benefit/cost comparison of the four proposed plans is not possible at the present time.

A source of sand for beach or dune restoration must be identified and selected regardless of what individual or combination of interim or long-term plans is implemented.

An updated benefit/cost ratio of the four erosion and flood control plans should be completed using the same methodology for each. An accurate comparison should follow an updated appraisal and funding sources explored to implement the most cost beneficial plan.

Strategies for obtaining financial contributions from permanent residents, developers, merchants and seasonal visitors who invest in the recreational amenities of Ocean City should be devised to compensate for additional costs of an erosion and flood control plan. Possible sources of funding include a transfer tax on sales of real property, a room tax on transient lodging, a general sales tax, and a property tax.

LAND USE CONTROLS

Land use controls in Ocean City should recognize that the delineation of flood hazard areas on a coastal barrier is imprecise because of uncertainities in the methodologies employed, and that the flood hazard is likely to increase gradually over time and dramatically following a major storm due to erosion. Consequently, the presently delineated flood zones on the Flood Insurance Rate Maps should be considered as the current minimum definition of flood hazard areas. Land use controls should be designed to protect people and property from flood damage over a long period of time -- not just from the hazard that exists today. Accordingly, several changes should be made in the plans, programs and regulations that govern land use in Ocean City.

Monitoring Storm and Beach Protection

Beach width and height varies extensively along the shoreline of Ocean City (see Figure 6) and on an average less than 5-year storm protection exists. With the implementation of a groin plan (i.e. status quo),

the cells or space between them will be filled to capacity with sand and provide 10-year protection. The beach will be wider and higher as a result of the replenishment effort, but the new beach must be maintained. To avoid costly engineering surveys, staffs graduated in feet can be placed along each groin cell enabling visual observation of beach loss or gain. Sand replenishment or redistribution can occur on the basis of observed change (e.g. between plus and minus three feet) over a long period of time or directly after a storm when erosion may be upwards of five feet. Sand that is overwashed into streets can be bulldozed back to the beach and used to establish dunes and rebuild the beach at specific elevations readily observed on the staff. Redistribution of sand may also be required as sand accretes at one side of the groin and erodes at the other.

The staffs will also provide a means of assessing the performance of groins and post-storm recovery of the beach. Comparison of beach changes in areas that have "new" groins versus those that don't may indicate their success or failure, may provide reasons to alter the construction plans (i.e. location of future groins) or justify the need for more or less groins over time. The current schedule of groin construction means that, if fully implemented, final completion will occur in 2008. This represents 25 years of seasonal and storm related changes acting differentially along the eight mile shoreline. Observation of these changes will help to guide the implementation of any groin or beach replenishment plan.

After a storm occurs, areas of obvious erosion can be observed. The immediate reaction is to bring sand (usually that which washed over into the streets) back to the beach. Pushing sand up from lower portions of the beach has also been done., This immediate response does not allow time for the beach to recover as it may naturally do (Hayes and Boothroyd, 1969 and Sonu, 1968). Within a period of days and perhaps

weeks, sand will return to the beach and replenishment will occur cost free. Suggested procedures for responding to the loss of beach and use of overwash sand following a storm are discussed more fully in the following chapter.

Revision of the Comprehensive Plan of Ocean City

The Comprehensive Plan of Ocean City, Maryland was adopted in 1969 and revised in 1978. City officials have indicated that they intend to revise the plan again during 1984. Currently, the plan contains only a minimum recognition of Ocean City's location on a coastal barrier exposed to serious erosion, flooding and storm winds. The plan does not propose long-range planning that takes these natural hazards into account.

When the Comprehensive Plan is revised, it should clearly state that living, investing and visiting in Ocean City can have many rewards. However, many of the positive benefits of life in Ocean City are a direct result of its location on a coastal barrier. Coastal barriers present hazards to both people and property, and the benefits of Ocean City life are accompanied by certain risks. For the visitor, the risk is extremely small -- the unlikely chance that a visit may be interrupted by the need to evacuate in advance of a major coastal storm. For the resident and investor, the risk is greater. All property in Ocean City is subject to damage from wind and floodwaters during major coastal storms. The risk to oceanfront property is even greater because of the possibility of wave damage and severe erosion. Residents and investors must be prepared to bear the cost of proper construction to safely withstand wind, water and erosion; occasional disruption of normal business and living activities because of the need to temporarily evacuate; the potential damage or loss of structures; and the potential loss of real property or the economic use of real property as a result of long-term or sudden erosion.

The Comprehensive Plan should include a statement of policy that recognizes the vulnerability of Ocean City to coastal hazards and the intent of the City to permit development and redevelopment only in locations and in a manner that provide adequate protection from a 100-year flood. Information should be included in the plan describing the current status of storm and beach protection measures (e.g. groin locations, dune stabilization efforts, etc.), and identifying the level of storm protection provided by these measures.

The policy should further state that the flood hazard areas in Ocean City are subject to both gradual and sudden change as a result of long-term erosion forces and storm impacts. Consequently, in order to protect people and property, it may be necessary to periodically reevaluate the flood hazard areas and adjust them as necessary, particularly following a major storm. The plan should indicate that after any necessary adjustment of flood hazard areas, the Comprehensive Plan, zoning regulations, floodplain regulations, erosion and sediment control regulations, the Building Limit Line, and other land use controls may have to be updated and revised to reflect the changes in delineation of hazard areas. Such changes could have an adverse impact on some property values.

Other provisions that should be included in the Comprehensive Plan include: an indication that various land use controls will be used to provide for appropriate setbacks from hazardous areas, particularly dunes and wetlands; zoning regulations will be used to provide appropriate placement of buildings on lots to allow for adequate passage of overwash water; an identification of approximate amounts and general location of additional open space that should be acquired or easements obtained to provide for adequate parking, off-beach recreation areas, and beach recreation; intent to develop and maintain the principal roadways and other infrastructure so that they are functional during the early stages of a coastal storm when evacuation would be necessary; to ensure that police, fire

and other emergency facilities are located so that they can provide protection to all parts of the City during a flood emergency and that the emergency facilities are elevated or floodproofed to provide protection from greater than a 100-year storm.

Ocean City Open Space Implementation Program.

An Ocean City Open Space Implementation Program should be developed as originally intended in 1971 and required by Section 36 of the Ocean City Code. The open space program should include the identification of properties to be acquired in fee simple and areas where public easements will be acquired. The purpose of these acquisions will be to ensure continued and improved public access to the beach, adequate parking facilities throughout Ocean City, and creation of small non-beach recreation areas. Special consideration should be given to acquiring properties for parking and off-beach recreation in those critical areas identified in this report as having the highest potential for breaching during a major storm. Each property to be acquired should be identified, the intended use of the property specified, the acquisition cost estimated, and development costs, if any, estimated. A schedule for property acquisition should be developed, and the loss in property tax revenue as a result of public acquisition should also be projected.

The specific means by which these properties will be acquired should be identified. Funding options include: an annual appropriation from the general fund as part of the normal operating budget; bonding (if several properties are to be acquired in a single year) with bond funds being repaid through the general fund or one of the special funds listed below; establishment of a special fund dedicated to open space acquisition. A special open space fund could be funded by the establishment of special taxes or fees such as: general sales tax, property tax, property transfer tax or fee, and a room tax on transient lodging.

Ocean City Zoning Regulations.

The Ocean City Zoning Regulations should be modified to include requirements that buildings constructed along the shorefront should be oriented on the lot in such a way that they provide the least obstruction to the movement of overwash waters during a major storm. The regulations should also require that structures be setback at least 20 feet from the crest of the dune. This setback will permit the dunes to perform their natural function of absorbing wave energy and will permit gradual landward movement of the dunes in response to coastal erosion and overwash processes, and, consequently, will reduce the frequency with which the Building Limit Line will have to be moved (an average increase of ten years, assuming an average rate of erosion of 2.5 feet/year). Buildings should be constructed to take into account the potential landward movement of the sand dune without adversely affecting use of the structure. One method of increasing building setbacks without affecting density provisions is to locate parking on the ocean side of high-rise buildings rather than on the landward side as is now generally the case. Ocean City should also conduct a study to determine the maximum capacity of residential units under existing zoning regulations, and relate this capacity to the time required to evacuate people from the City. Depending upon the results, it may be advisable to reduce current density allowances.

The zoning regulations should also establish a minimum setback from wetlands on the bay side of Ocean City. A setback of about twenty-five feet should generally be adequate to protect the wetlands from construction related activities and pedestrian access to the wetland side of the structure. Although under natural conditions, land along the bay side should gradually extend into the bay as sediment is trapped by the wetland plants and overwash sand is deposited on land and in the bay, current conditions limit this natural process and may even cause erosion in some locations. Bayward movement of land is restricted or halted by the removal of overwash sand from properties and by the placement of

bulkheads. Some bulkheads along Isle of Wight Bay have failed as strong currents in the Bay have migrated toward the shore. Establishment of setback regulations along the bays should help to protect structures from damage or failure due to erosion.

Ocean City Erosion and Sediment Control Regulations.

Beach Erosion Control District: The Ocean City Erosion and Sediment Control Regulations should be revised to provide improved protection to existing dunes. The regulations should prohibit the construction of buildings within the Beach Erosion Control District (the area east of the dune crest). They should also prohibit the destruction of any existing natural dune. These regulations would then place more restrictive controls on building along most parts of the beachfront than does the present State-Ocean City Building Limit Line, and the most restrictive regulation should apply in each case.

Current requirements for property owner formation and maintenance of dunes should be retained and strictly enforced by the City. However, the requirement that the dune be vegetated to five feet above MLW should be relaxed to require vegetation to the toe of the dune or to an appropriate elevation specified by the Worcester Soil Conservation District. Attempting to vegetate the dune to a point five feet above MLW (1.6 feet above MHW) appears impractical. Dune protection should be strengthened by requiring limited access over the dunes by use of wooden walkways or other means approved by the Worcester Soil Conservation District. When the elevation of the existing dune is less than 12 feet above MLW, the property owner, as a requirement of a building permit, should be required to increase the height of the dune to 16 feet above MLW and maintain the dune according to plans approved by the Worcester Soil Conservation District. The State of Maryland should carefully monitor the City's enforcement of the regulation under the authority of the State Sediment Control Law.

The Worcester Soil Conservation District should continue its current program of working with property owners to restore and maintain dunes in front of existing buildings. Participation in this restoration program should be required by the City in accordance with the provisions of its Erosion and Sediment Control regulations.

Bay Erosion Control District. The Bay Erosion Control District regulations should be strengthened to control the development of additional canals in Ocean City. The development of canals perpendicular to the barrier and extending near the coastal highway greatly increase the potential for breaching of the barrier during a major storm. Construction of new canals is now limited because of the State Wetlands Act. Nevertheless, it would still be possible to construct canals in some areas that would have a minimum impact on wetlands. Such canals should not be permitted if they increase the potential for barrier breaching. The Worcester Soil Conservation District should be required to evaluate all proposed new canals for their impact on breach potential. In general, new canals should be permitted only when they are constructed parallel to the barrier, and they should not be allowed to reduce the surface width of the barrier west of the coastal highway to less than 200 feet. The Bay Erosion Control District should also be revised to include a twenty-five foot setback from wetlands.

State-Ocean City Building Limit Line Authority.
The existing Ocean City Building Limit Line ordinance has been superceded by the 1975 State legislation. The State legislation that established the State/Ocean City Building Limit Line required DNR to establish the line so that it more or less coincided with the previous line established by Ocean City. Therefore, the Building Limit Line appears by legislation to be a fixed line. Certaintly, the local building community and officials have viewed the line as fixed -- that it would not be moved in the future.

Nevertheless, a fixed building limit line on a coastal barrier subject to erosion will eventually prove inadequate to protect property from storm damage and to maintain a viable recreational beach. Over time, without expensive means of stablization, the beach will erode. Earlier chapters of this report have described how Ocean City can expect erosion, both gradually and in dramatic increments during storms. According to the Corps of Engineers (COE, 1980), there should be a distance of about 300 feet, including a 16 foot high dune, between mean high water and the BLL in order to provide Ocean City with protection from a 100-year storm. At present the distance between mean high water and the BLL averages only about 135 feet. Protective dunes are largely absent from the beach, further increasing the potential for beach erosion and property damage. Continuing to build to the limits of the existing Building Limit Line in the face of almost certain erosion will likely result in an increased rate of erosion, greater property damage, and a narrower recreational beach.

To protect property from damage and to maintain a viable recreational beach, the width of the beach must be increased and sand dunes of proper width and height established and maintained. As discussed earlier in this report, development of this wide beach through a beach nourishment project as recommended by the Corps of Engineers is unlikely to occur because of high costs and changes in federal priorities. Continuing to place groins along the beach and fill the groin cells to capacity with sand will provide only about a 10-year storm protection. The only other alternative for increasing storm protection and maintaining a recreational beach is to allow the beach to widen naturally by moving the BLL further inland.

Moving the BLL inland poses many problems. Many developed lots would become nonconforming, and many undeveloped or underdeveloped lots would be able to support only smaller development or no development at all

under existing zoning regulations. Movement of the BLL would also not result in immediate development of a wide beach: existing buildings would remain. Only new development or redevelopment would be prevented within the area needed for the beach. Questions of compensation for property owners denied building permits would also arise. Under existing State legislation, the State may acquire property in cases where the Attorney General determines that an unconstitutional taking of property results from the imposition of the BLL.

Dispite the problems that will occur with movement of the BLL, we feel that, in view of the limited long-term potential for storm protection and beach preservation under other options, the BLL should be gradually moved inland. To accomplish this, both the Ocean City ordinance and the State legislation should be revised to provide for a Building Limit Line that can be moved periodically in accordance with clearly established procedures designed to protect property and the health and safety of Ocean City residents and tourists, and to ensure the continued existence of public beaches in Ocean City. The following criteria are suggested for determining when the Building Limit Line should be moved. We recommend that the City Ordinance and State legislation be revised in accordance with these criteria.

1) In order to provide adequate advance notice to all current property owners that might be affected by a change in the location of the Building Limit Line, the BLL should not be changed for at least five years from the time that City and State legislation is modified to permit relocation of the BLL, unless, a single storm causes such severe erosion that it would be unsafe to allow new construction or redevelopment to the existing BLL.
2) The BLL should be relocated only if, and in those locations where, erosion has reduced the distance between mean high water and the BLL to less than 150 feet. This condition could be caused

by a single storm that causes severe erosion or gradual erosion over a period of years.

3) Movement of the line would not affect existing buildings that were not damaged or were damaged only slightly. It would affect new building and redevelopment and repair of buildings damaged more than 50% of market value.

4) The BLL should be moved in minimum segments. Since streets perpendicular to the beach are the easiest way to define areas in Ocean City, it is suggested that a determination to move the BLL be made on the basis of streets. No segment of the BLL less than the distance between two streets should be redefined. This movement would occur if measurements of the distance between the MHW and the existng BLL were reduced on average within that stretch of beach to less than 150 feet.

5) When the BLL is moved, it should be moved landward far enough to provide for a distance of at least 200 feet between mean high water and the newly established BLL.

Funding for acquisition of properties denied a building permit as a result of any movement of the BLL should continue to come from the State of Maryland. The State receives financial benefits from revenues generated in Ocean City and returned to the State treasury. State residents also benefit from maintenance of a viable recreational beach and safe lodgings and other tourism attractions in Ocean City. Therefore, the State should be willing to invest in additional oceanfront acquisition in Ocean City. Ocean City will incur long-term costs through reductions in property taxes from land transferred to public ownership and possibly through a total reduction in property improvements and business investments.

Not all properties denied building permits as a result of relocation of the BLL should be acquired by the State. In many, if not most, cases the property owner should be required to absorb whatever financial losses

may result. With appropriate changes in the Comprehensive Plan of Ocean City and the Ocean City and State of Maryland authorities establishing the Building Limit Line, property owners will have advance notice that buildable oceanfront property is subject to a reduction in size as a consequence of natural erosion and the need to limit buildings in hazardous areas to protect the safety of residents and visitors. In cases where permanent structures are denied based on the existence of a flood hazard, courts have generally held that there is no unconstitutional taking of property. This concept may have to be tested in Maryland courts for the Ocean City situation.

Worcester County Zoning and Subdivision Regulations.

The Worcester County Zoning and Subdivision Control regulations should be amended to provide for a minimum twenty-five foot setback from tidal (and freshwater) wetlands, except where construction in wetlands is permitted by the State. Construction and other activities should be permitted within the setback zone only if there will be no adverse impact on the wetlands and if the use is necessary for access to the waterfront, e.g. piers and docks. The setback provision should reduce development directly on the bayfront and construction of bulkheads that alter the natural land/water interface.

Worcester County should also review is current zoning map for conformance with the Worcester County Comprehensive Plan with regard to zoning of land fronting on Isle of Wight and Assawoman Bays. The Comprehensive Plan recommends that most of the bayfront property be zoned for "Conservation," with very limited development. The existing zoning map has a much greater portion of the bayfront property zoned for various residential and commercial uses than is recommended in the Comprehensive Plan. To the extent possible (areas that are not already developed), zoning of bayfront areas should be "Conservation" as recommended in the Comprehensive Plan.

Worcester County Shoreline Construction.

These regulations should be amended to include provisions for the maintenance of any permitted structures such as rip-rap, piers, and bulkheads. Maintenance of rip-rap and bulkheads is particularly important since erosion may result if the structures are allowed to deteriorate. This is especially important in areas where canals are constructed. The regulations should attempt to keep the use of rip-rap and bulkheading to a minimum, especially on the bay side of Ocean City. Use of rip-rap and bulkheading will retard or prevent the normal process of gradual land build-up into the bay.

CONSTRUCTION STANDARDS

Construction standards should also recognize the uncertain and conservative nature of hazard area delineation on a barrier island and be modified accordingly.

Ocean City Building Construction Code and Foundation Regulations in Critical Areas.

The current building code and foundation regulations in critical areas for Ocean City should be supplemented and ammended, as appropriate, with the best available specific standards for construction in coastal flood hazard areas. The best currently available information is found in the FEMA document Design and Construction Manual for Residential Buildings in Coastal High Hazard Areas, published in 1981. A sample ordinance that has been proposed for use in Sanibel, Florida to supplement their local building code (Standard Building Code) is being provided to Ocean City separately from this report. This sample ordinance could be used by Ocean City as a model for developing its own supplement to the the Standard Building Code to provide improved protection from hurricane hazards. Because of the potential for breaching of Fenwick Island during

a major storm, expecially due to washover of floodwaters from the bay to the ocean, structures built near the bay may be subject to forces of erosion and velocity waters similar to those expected in designated V-zones. Consequently, it is suggested that all structures within 200 feet of mean high water on the bay side of Ocean City be required to meet foundation construction standards similar to those presently required in the oceanfront critical areas under the Foundation Regulations in Critical Areas. In addition, all low-rise residential buildings in Ocean City should be required to meet specific standards for wind resistance as described in the FEMA Coastal Construction Manual (FEMA, 1981). These specific standards regarding foundations, types of materials, adequate connection of the foundation to other parts of the structure, and other construction techniques should be specified in a supplement to the existing Ocean City building code. For high-rise structures, the performance standards currently in the building code should be retained. Enforcement of the current and future revisions to the building code should be a high priority. Construction proposals should be carefully reviewed for compliance with the building code, and frequent inspections should be performed during construction to ensure that all approved building plans are strictly complied with, especially foundation requirements and other aspects of construction that are not visible after work is completed.

Ocean City Flood Damage Controls.

Ocean City should amend its Flood Damage Controls regulations to require that buildings be elevated to at least one foot above the base flood elevation as specified on the FEMA Flood Insurance Rate Maps. In the case of nonresidential construction in A-zones, the option of floodproofing should also be required to extend to one foot above the base flood elevation. These more stringent requirements will provide a margin of safety to account for errors in the flood insurance studies, damage from floating and wave-tossed debris, and changes in flood hazard over

time. In the event -- as suggested below -- that Ocean City should revise its base flood elevations before needed revisions are officially approved by FEMA, the Flood Damage Controls regulations should be modified to reference the newly developed flood hazard maps rather than the FEMA FIRM's. The regulations should also be amended to include provisions that severely limit the use of seawalls and bulkheads for oceanfront buildings in order to avoid adverse impacts on adjacent properties. Vertical bulkheads or seawalls should not be permitted on any property unless it lies between adjacent properties that are protected by vertical walls.

Worcester County Building Code.

Worcester County should adopt either the Standard Building Code or the BOCA Code as a uniform code for the County. A building inspector should be hired to issue permits and ensure that all construction is in conformance with the code.

Worcester County Floodplain Management Regulations.

As in Ocean City, these regulations should be modified to require that buildings be elevated (elevated or floodprofed for nonresidential construction) to at least one foot above the base flood elevation.

State of Maryland Erosion Control Law.

The State should not grant additional interest-free loans for the construction of seawalls and bulkheads to protect oceanfront buildings in Ocean City because of the potential for adverse impacts on adjacent properties.

WARNING AND EVACUATION PROCEDURES

A more detailed and complete Emergency Operations Plan should be developed that:

- Determines the time required for evacuation given different population levels, the capacity of evacuation routes, including impediments to evacuation such as road level below flood level and use of evacuation routes by other communities. This evaluation should be conducted in cooperation with Worcester County and take into account evacuation requirements of other parts of Worcester County and nearby communities in Delaware.
- Evaluates evacuation time compared to expected warning time to be provided by the National Weather Service, and if evacuation time exceeds warning time, identifies measures to improve the capacity of evacuation routes, limit development or other appropriate actions.
- Provides guidance to owners/managers of motels and condominiums for development of their own warning and evacuation procedures which will be coordinated with the Ocean City Emergency Operations Plan.
- Provides for evacuation procedures for special segments of the population such as the elderly, handicapped, and families of emergency workers.

Additional State investments that would permit or encourage growth in Ocean City should not be made unless and until a detailed evacuation plan has been prepared that clearly demonstrates the ability to evacuate the population with available warning time.

Just as Ocean City needs to prepare for the next major storm by undertaking the types of mitigation actions recommended in the preceeding chapters, it also needs to prepare for what will happen after a disastrous storm occurs: to prepare for recovery, restoration and mitigation.

Ocean City is fortunate not to have been affected by a major storm in over 20 years. Inevitably though, other major storms will strike the City. The next storm may cause damages greater or lesser than the 1962 Ash Wednesday storm. Whatever the level of damages, the City will be faced with many hard decisions regarding recovery and reconstruction. Many of these decisions must be made even before emergency relief and rescue operations have ended, and will continue for several months. The burdens placed on local and State officials during this period will be severe.

Most communities are not well prepared to deal with a natural disaster. Although officials and citizens, usually aided by State and federal governments and charitable relief organizations, exert enormous efforts and cooperation in coping with the effects of the disaster, the toll in personal stress and both personal and community economic loss is great. Commonly, the pressures for immediate individual and community recovery are so great that communities rebuild to pre-storm design, making them nearly as vulnerable to a natural disaster as before. Little or no hazard mitigation action is taken.

Currently, Ocean City is not prepared to provide the most effective response following a disaster. The City does have an Emergency Operations Plan, but it deals mainly with emergency evacuation, flood fighting, and life saving efforts. The plan does not address in any substantative way what the City will need to do after these emergency measures are completed -- how the City will cope with recovery from the disaster and what it can do to reduce its future vulnerability to flood losses.

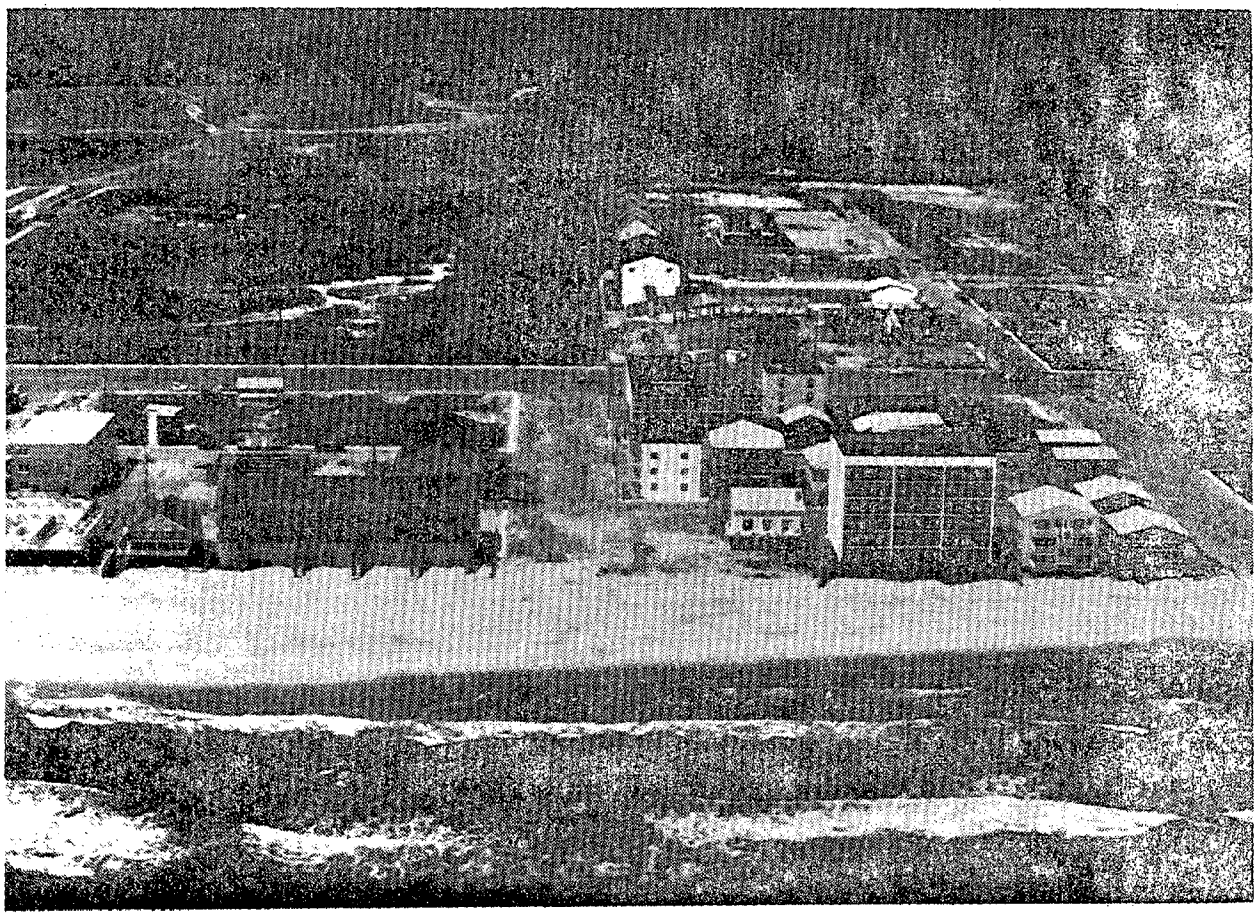
Although the disruption caused by a major disaster cannot be eliminated, it can be reduced if Ocean City prepares itself now to deal with the aftermath of a disaster. Ocean City can also seize the disaster as an opportunity to correct some of the previous land use and construction decisions that may have contributed to storm losses. Just as important will be the need to determine if the City is left in a more vulnerable position than it was before the storm and to take appropriate actions regarding redevelopment.

The specific type and extent of mitigation measures to be taken after a disaster will depend upon when in the future the storm occurrs, how devastating the storm is, and how many of the mitigation measures recommended earlier in this report have been implemented at that time.

After a disaster strikes, some members of the community will wish to rebuild to essentially the pre-disaster conditions as quickly as possible, others will wish to rebuild in a fashion which they feel is more efficient, equitable and attractive, and others will press for implementation of various hazard mitigation measures that may not have been feasible prior to the disaster. Balancing these community desires will be difficult, and if the City is not prepared beforehand to deal with them, it may find that the recovery proceeds without much control.

To better equip itself to make the necessary post-disaster decisions, Ocean City needs to do some planning before the disaster strikes. In undertaking this planning, it is important to recognize the post-disaster situation within which the decisions will be made. Some decisions that the City and State will need to make will be constrained by the disaster assistance policies, procedures, and financial aid provided by the federal government. Still other decisions will be constrained by the effects of the storm on the geomorphology of the barrier.

AFTER THE STORM:



GUIDING REDEVELOPMENT

Pre-disaster planning for post-disaster actions must be done by the involved State and City officials, with appropriate citizen involvement and technical assistance. The remainer of this chapter identifies and discusses the types of pre-disaster planning that should occur. This information should serve as guidance to the City and State in the development of policies and procedures tailored specifically to Ocean City's needs and which can be incorporated into appropriate City documents such as the Comprehensive Plan and Emergency Operations Plan.

ESTABLISHMENT OF NECESSARY AUTHORITIES AND PROCEDURES

Obviously if Ocean City is to be prepared to act effectively after a disaster, it must prepare itself beforehand. Most prominent among the items for preparation is development of a post-disaster recovery/mitigation plan which is discussed in the next section. But there are other things that should be done to alert the residents and property owners of Ocean City of the types of actions that may be taken after a disaster and to establish the proper authority to act after a disaster. These are discussed below.

REVISION OF THE COMPREHENSIVE PLAN OF OCEAN CITY

In Chapter 4, several revisions to the Comprehensive Plan of Ocean City were recommended. In addition to those changes and additions, the Comprenensive Plan should also indicate that a Post-Disaster Recovery/Mitigation Plan should be prepared and maintained. This plan should be carefully coordinated with the Emergency Operations Plans for Ocean City and Worcester County. The recovery/mitigation plan should reflect the general land use goals and policies contained in the Comprehensive Plan of Ocean City.

AUTHORITY TO IMPOSE A TEMPORARY BUILDING MORATORIUM

After a disaster, important opportunities for flood hazard mitigation are often lost because property owners immediately begin repairing or rebuilding their damaged structures in the same location and to the same level of protection as before the storm. Three factors often combine to yield this result:

(1) The community's permitting officials are overworked, and they are not able to give each application the attention it needs to assure compliance with applicable requirements. Also, property owners may undertake repair or reconstruction without seeking a required permit, and the overworked

officials are unable to identify and halt these unauthorized activities.

(2) The desire by community officials to reduce the impacts of the disaster often cause them to suspend enforcement of many regulatory requirements, even though some of those requirements may be especially appropriate in a post-disaster situation.

(3) Officials and residents are unaware or uncertain as to just what changes they should make during repair or reconstruction to make their structures less vulnerable to the next major storm.

Imposition of a temporary building moratorium can avoid this situation and provide time to reassess the City's flood hazard vulnerability and identify hazard mitigation opportunities. Temporary building moratoriums have been used successfully in other communities after floods and other disasters.

Currently, Ocean City does not have a clear authority to impose a temporary building moratorium. Although such a moratorium could be imposed by the Mayor and Council after a disaster occurred, it could be challanged, might be unwelcome, and might not be enacted in time to be completely effective. To avoid this uncertainty, the Mayor and City Council should act now to establish the clear legal authority to impose a temporary moratorium on all repairs, redevelopment and new development following a natural disaster. The maximum duration of the moratorium should be identified (e.g., six months). The authority should also include provisions for lifting the moratorium on "minor" repair and rehabilitation before it is lifted on "major" reconstruction and new development. Suggested procedures for the temporary moratorium are discussed more fully in the following section.

APPOINTMENT OF SPECIAL TEAMS AND TASK FORCES

Recovery from a disaster will require duties that are beyond the normal scope of City officials and employees. Special needs will have to be met such as damage assessment, evaluation of hazard vulnerability, evaluation

of effectiveness of current hazard mitigation requirements, and identification of additional hazard mitigation opportunities as well as coordination of the entire recovery effort. These activities can be partially handled by City officials and staff, but some efforts may require or benefit from the assistance of citizens with specialized expertise and the use of outside services. The following special teams and task forces should be established:

Initial Damage Assessment Team
Damage Assessment Teams
Damage Survey Teams
Disaster Recovery Task Force
Property Acquisition Advisory Committee
Permitting Task Force
Property Owner Notification Committee

The duties of these teams are described below and in the following section. Individuals should be assigned to the various groups and briefed on their responsibilities prior to a disaster. Written descriptions of their responsibilities should be prepared. In some cases, table-top or field training exercises should be held periodically as part of preparedness exercises for the Emergecny Operations Plan.

Disaster Recovery Task Force

A Disaster Recovery Task Force should be appointed by the Mayor and City Council as soon as possible. This task force will be responsible for developing the Post Disaster Recovery/Mitigation Plan and for assisting the Mayor, City Council and City Manager in supervising the actual recovery process following a disaster. The task force should be composed of key city officials with planning, permitting, and emergency responsibilities plus representatives from the public who have expertise in these fields.

Property Acquisition Advisory Committee

This committee should be composed of City officials responsible for planning and development and several property owners from throughout the City. The purpose of the committee is to inspect damaged areas after the disaster (expecially along the oceanfront, bayfront and any areas of total or partial breaching), evaluate the amount of erosion that has occurred and the changes in flood and erosion hazards, to make recommendations to the City and State regarding relocation of the Building Limit Line, and to make recommendations to the City regarding acquisition of additional properties after the disaster. Prior to a major storm, the committee could also be used to assist City staff and officials in developing and carrying out the Ocean City Open Space Implementation Program.

Permitting Task Force

After a disaster, the local Building Inspector, City Engineer and other officials responsible for issuing building permits and inspecting construction will be extremely overburdened with work. They will need assistance in order to process permit applications properly and in a minimum of time. This task force should be headed by the City Engineer and the Building Inspector and inlcude members of the public with real estate, development and construction experience. The task force should participate in inspecting damaged properties and processing the necessary paperwork. The task force should be used primarily to help expeditiously process permits for minor repairs to damaged buildings. This assistance can give more time to the City Engineer and Building Inspectior to concentrate on buildings with major damage.

Property Owner Notification Committee

Because of the large number of non-resident property owners in Ocean City, it will be especially important following a disaster to rapidly inform all property owners of the nature of damage that may have been

suffered by their property and of any special post-disaster conditions that may apply, such as a temporary building moratorium, special procedures for building permits, and the need to remove debris from property or to correct unsafe or unsanitary conditions caused by the disaster. This committee should be composed of local officials such as the Town Clerk and Tax Assessor along with several members of the public. Their primary purposes will be to gather the information on each property and to notify the owners of the conditions mentioned above. The committee should be appointed so that they may establish all procedures prior to a disaster and proceed with implementation as quickly after the disaster as possible.

IDENTIFICATION OF OUTSIDE PRODUCTS AND SERVICES

Outside services or products that may be needed during the recovery stage should be identified, to the extent possible. Examples include: Surveying team for determining beach erosion; bulldozers, dump trucks and other heavy equipment for removing sand and debris from public and private property; engineering, hydrological, and geological services to reassess the flood hazard zones; structural engineering services to assist with evaluation of the adequacy of building code requirements and construction techniques. Even if the particular company or individual who will ultimately be requested to provide these services is not identified prior to the disaster, it is important to be aware that the services may be needed and to have knowledge of where the services may be obtained. Because these types of services may also be in demand from other communities and individuals who have also been severely affected by the disaster, the most prudent course would be to have a written or verbal agreement with one or more of the providers of the services that they would be available to Ocean City if needed.

SOURCES OF FUNDING FOR DISASTER RECOVERY AND MITIGATION

After a disaster, Ocean City will be faced with extraordinary expenses

at a time when normal revenues may be reduced. Disaster aid from the federal and State governments and from private charitable organizations will cover a large part -- but not all -- of the costs of recovery. Ocean City should decide before a disaster how it will pay for the majority of these extraordinary expenses. The State of Maryland should also decide what role it will play in assisting disaster recovery and mitigation. Several options that the State and City could pursue are discussed below.

Funds for Restoration of Damaged Public Facilities.

If a major disaster declaration is made by the President, Ocean City and other areas of Worcester County and Maryland that are included in the disaster declaration will be eligible to receive reimbursement from the President's Disaster Relief Fund, administered by FEMA, for all qualifying damages directly caused by the storm. The remaining 25% of eligible costs, plus the costs of any necessary repair or replacement costs that are not directly related to the storm, will have to come from State and/or local sources.

Currently, the State of Maryland does not have an established policy regarding what portion of disaster assistance it will pay to help local governments. Most commonly, states have been paying half (12.5%) and the local government has paid half (12.5%) of eligible disaster costs not covered by the federal government. In at least one case (Connecticut in 1982), the state government paid the entire amount not paid by the federal government, leaving local jurisdictions with only administrative costs and expenses not eligible for reimbursement under Federal policies. We recommend that the State of Maryland adopt a policy of paying 12.5% of the disaster costs determined eligible by the federal government. This would require Ocean City and other Maryland local jurisdictions to pay the remaining 12.5% of eligible costs, plus additional expenses for administrative costs and ineligible expenses.

In addition, we recommend that the State also provide local jurisdictions with loans to cover the 12.5 percent of disaster recovery costs to be paid by local government. Local governments will be the most directly and severely affected by a disaster and their economic position may be significantly weakened by damages to public property and income losses due to private property business losses. The State will be in a better position to provide the initial funds for recovery than will local governments. The State can bond sufficient funds to initially cover the entire costs of the State and local share of disaster assistance. Local governments can then repay the State for their 12.5 percent share of the costs, plus sufficient interest to cover the interest on State bonds and State administrative costs of handling the funds.

Not all costs of repairing and reconstructing public facilities will be eligible for reimbursement by the federal government. Any costs that result from deterioration or repair needs that existed before the storm will not be paid by FEMA. Unless, the State already has a financial interest in the public facility, we recommend that these additional costs be borne by the local government.

The federal government will only pay for an additional 15 percent of the costs to upgrade or improve public facilities if improvements are needed to provide for hazard mitigation. Currently, a legislative amendment (Senate Bill 1525, Section 15) has been proposed that would permit 2.5% of all disaster relief funds to be used for hazard mitigation. Until this or similar legislation is approved, Ocean City and the State of Maryland should be prepared to fund necessary hazard mitigation actions. We recommend that the State and Ocean City share the costs of hazard mitigation 50/50. This 50/50 share should be applied to all post-disaster mitigation projects where the federal government will provide a portion of the costs, e.g. FEMA disaster assistance (75%) and SCS non-exigency projects (80%). The State and Ocean City should be prepared to immediately

issue bonds to raise the necessary costs. (Note that the need to know how much to bond for makes it especially important to prepare accurate damage assessments).

In the event that the Governor requests the President to declare a "major disaster", but no declaration or only an "emergency" declaration is given, we suggest that the costs of disaster recovery be shared equally by the State and local government. If the Governor, as advised by the Maryland Emergency Management and Civil Defense Agency (EMCDA), determines that the damage is severe enough to warrant a presidential declaration of a major disaster, then the State should be prepared to assist with the cost of recovery even if the declaration is not forthcoming. In this instance, the state EMCDA should determine eligible costs following a procedure similar to those used by FEMA for major disasters.

Funds for Acquisition of Open Space Land

As discussed in Chapter 4, we recommend that the State of Maryland continue to acquire properties denied a building permit because of the location of the Building Limit Line, whenever the permit denial would result in an unconstitutional taking of the land. After a major disaster, it is probable that extensive erosion will have occurred and that the BLL will be moved inland at some locations in Ocean City. The State should participate with Ocean City in determining the extent of erosion and quickly estimating the locations where the BLL will probably need to be moved. The State should then estimate the cost of acquiring additional properties as a result of moving the BLL. These costs should be included in the amount bonded to pay the State's share of disaster assistance costs. Properties acquired as a result of movement of the BLL should be purchased at their post-disaster value.

Ocean City should use its special fund for open space acquisition (see Chapter 4) to purchase additional open space land and open space easements

after the disaster. In some cases, property denied a building permit as a result of movement of the BLL will not be acquired by the State because the clear existence of a flood or erosion hazard on the property will mean that there is no unconstitutional taking of property. In these instances, the City should be prepared to either purchase the property in fee or to purchase a public easement to ensure that there is unrestricted public access to the beach.

Funding Economic Recovery for Individuals and Businesses.
After a major disaster declaration, individuals and businesses will be eligible for SBA loans. Individuals may also be eligible for grants up to $5,000 from FEMA and/or for temporary housing and other forms of federal financial assistance. Often, this aid is inadequate to help many homeowners and businesses recover from the disaster.

Ocean City should assist these individuals and businesses in at least two ways. First, property taxes should be temporarily reduced by an amount equivalent to the percent of damage suffered to the property. Second, a fund should be established to provide low-interest loans to individuals and businesses to help them recover from the disaster. The funds for this low-interest loan program could be established either before or after the disaster, and could come from a special surcharge on the property tax, building permits or other local taxes and fees.

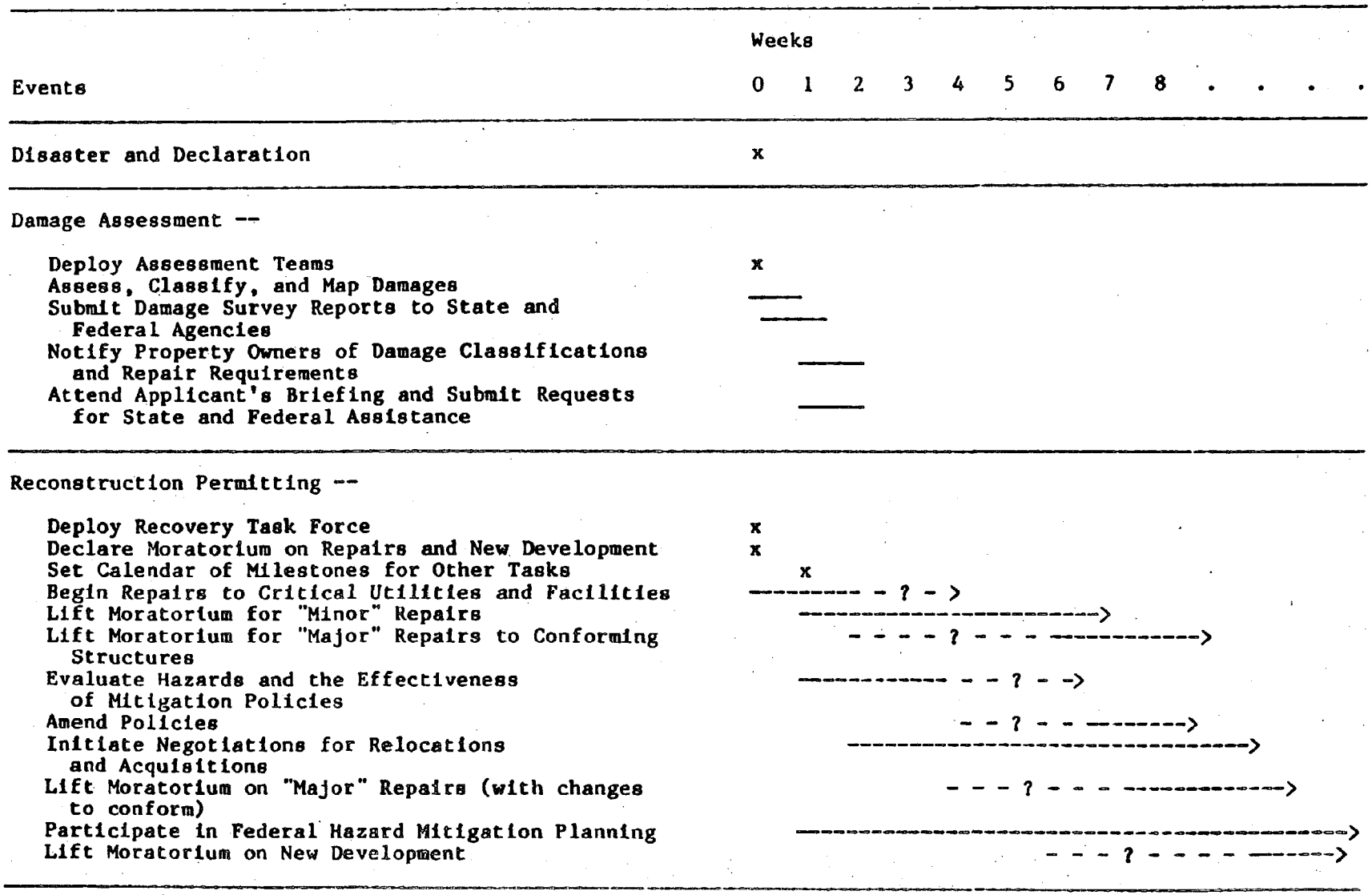
POST-DISASTER RECOVERY/MITIGATION PLAN

A Post-Disaster Recovery/Mitigation Plan should be prepared before the disaster to avoid unnecessary confusion, delay and inappropriate actions after the disaster. The purpose of the plan is to expedite recovery from the disaster while also identifying ways to mitigate future loss potential. The plan should identify the actions and decisions that will be needed after the disaster, who is responsible for each decision or action, and the criteria upon which the decisions will be made. The plan should identify any special roles that City officials, employees and citizens may have in the recovery effort, such as a recovery task force and damage assessment teams. It should also identify any types of services needed that may be beyond the capability of the local government during the disaster and for which outside assistance will be required. Figure 13 lists the major activities that Ocean City will need to undertake following a disaster. Each of these activities is discussed below.

Some of the activities involved in the recovery plan are the same as activities already addressed in the Ocean City Emergency Operations Plan, such as damage assessment. Other recovery activities such as hazard mitigation evaluation may require a modification of the way some emergency operations are normally handled, e.g. non-emergency debris removal should not occur until the debris can be examined for evidence of the specific causes of damage. Therefore, the recovery plan should be coordinated with and actually be a part of the Ocean City Emergency Operations Plan.

The discussion that follows should be used by Ocean City as the basis for development of a detailed post-disaster recovery/mitigation plan.

Figure 13. Sequence of local activities in assessing damages and permitting reconstruction.



Source Before the Storm, Univ. of North Carolina, 1982

While the material included below covers most of the things that the City should do, it is important that the decisions and activities that the City will undertake be thoroughly and carefully discussed by City officials. They should be thoroughly familiar with and in agreement with the plan.

EMERGENCY OR DISASTER DECLARATION

State of Emergency Declaration.

Immediately after a storm has passed, the Mayor and City Council will have to decide how severe the damage is and whether they should declare a state of emergency (or a continued state of emergency if an emergency was declared as the storm approached). They will also need to decide if they will seek outside assistance.

An emergency should be declared or continued if the results of the initial damage assessment indicate that the public health or safety is threatened because:

a) transportation on the major routes into and through Ocean City is disrupted;
b) public utilities are disrupted;
c) there is significant damage to residential and business property; and
d) there is concern about looting.

The emergency should remain in effect until the Mayor and City Council determine that the above conditions have been improved so that there is no longer a serious threat to public health and safety.

Temporary Moratorium.

The declaration of an emergency or disaster in Ocean City should automat-

ically result in the imposition of a temporary building moratorium. The length of the building moratorium and the specific conditions under which it will be administered should not be determined until after damage assessments have been completed.

DAMAGE ASSESSMENTS

Damage assessment will be the first step in the recovery and redevelopment process. Damage assessments may occur more than once during disaster recovery and serve several purposes. In each instance it will be necessary to assess the damages, classify the damages by several categories, and map the location of the damaged property.

Initial Damage Assessment

In order to determine if an emergency should be declared, an Initial Damage Assessment Team should be dispatched to perform an initial damage assessment of Ocean City (the same applies in Worcester County). This team will be responsible for conducting the initial damage assessment as soon as it is safe to move through Ocean City. This initial assessment is strictly a windshield assessment and should be completed in a matter of hours. Depending upon the post-disaster conditions, this "windshield" assessment may be made by automobile or heavy-duty vehicle, boat, helicopter or some combinations of these means of transportation.

The purpose of this assessment is to make a general determination of the location, types and severity of damages suffered by Ocean City. The information gathered by this team will be used by the Mayor and City Council to make decisions regarding the declaration or continuation of a local emergency, imposition of a temporary building moratorium, and requesting State and federal disaster aid. The team should include the City Manager, Building Inspector, Town Engineer, Fire Chief and Police Chief. If possible, representatives from the Maryland EMCDA

should accompany this initial damage assessment team on their inspection tour.

Damage Assessment Teams

The second damage assessment will occur as soon as the damage assessment teams can be assembled and given their assignments. Damage assessment teams may need to be established for different categories of property. For example, there may be teams assigned to public property (buildings, equipment, roads, bridges, sewer, water, etc.); commercial establishments (retail stores, restaurants, hotels and motels, etc.); and residential property (individual private dwellings, mobile homes, condominiums). The composition of each team may differ in order to provide the greatest expertise in making the damage assessments. Teams may be organized according to other categories than those listed above (e.g. type of construction), and Ocean City officials should determine which grouping and assignments are most appropriate given the expertise of available officials and volunteers.

Each team should be supplied with forms and maps for recording the damages. These forms should provide for recording information in a format that is consistent with the information required by the Federal Emergency Management Agency for federal disaster assistnace and by the Maryland EMCDA. They should also provide for assistance information that will be important for local decision making. For example it will be important to classify private property according to whether it was damaged 50% or more of market value. Properties damaged more than 50% of market value will be required to comply with the Flood Damage Controls and other sections of the Ocean City code relating to nonconforming uses.

In addition to recording damages to property, the damage assessment teams should also determine the cause of damages. The structure should

be examined as well as the surrounding area, including debris that may be left on the property. Damages should be classified according to whether it was caused by wind, direct impact of waves, overwash (either from the ocean to bay or bay to ocean), high water levels, wind blown debris, water tossed debris, or a combination of two or more of the above categories. This information will be essential for determining the effectiveness of the existing hazard mitigation measures in Ocean City and for identifying possible new hazard mitigation measures.

State, and possibly federal representatives, may assist in this damage assessment effort. This more detailed damage assessment should be completed within two to five days of the disaster. The results of this second damage survey should be submitted to State and federal agencies as part of the process of applying for federal disaster assistance.

Damage Survey Reports.

If a presidential disaster declaration is made, the damage assessment teams will also be involved in still another round of damage assessments. FEMA will assign teams of federal and State employees to prepare Damage Survey Reports. These reports will verify the damage assessments submitted to the State and federal government by the Ocean City damage assessment team and will determine the extent to which the properties are eligible for federal assistance. These Damage Survey Reports will be prepared over a period of weeks or months. It is important for the Ocean City damage assessment teams to accompany the federal/State team on their inspections so that they can clarify information concerning their earlier damage assessments and provide information about the cause of damages that may no longer be evident because of debris removal or other reasons.

RECONSTRUCTION PERMITTING

Deploy Recovery Task Force.

As soon as the Mayor and City Council determine that an emergency or disaster exists, the Recovery Task Force should begin functioning to assist in the overall supervision of the disaster recovery and mitigation efforts. One of the major responsibilities of this task force during the post-disaster period will be to try and avoid conflicts between recovery actions and hazard mitigation needs. Although this will not always be possible, the task force should provide a mitigation as well as recovery oversight perspective and call attention to recovery actions that may preclude hazard mitigation actions.

Begin Repairs to Critical Utilities and Facilities.

As soon as possible the City and public utilities should begin temporary and permanent repairs to all critical facilities. Repairs and reconstruction should be made in accordance with the Comprehensive Plan of Development and elevation and floodproofing requirements to reduce flood damages. All critical facilities that suffered substantial damage, such as public utilities, police, fire, medical, and municipal records should either be elevated or floodproofed to avoid damages during a 500-year storm rather than a 100-year storm.

Clarify Temporary Building Moratorium and Establish Recovery Milestones.

Another function of the Recovery Task Force should be to advise the Mayor, City Council and City Manager in establishing the overall program for disaster recovery and mitigation. As soon as the damage assessments are completed, the conditions of the temporary building moratorium should be established and a schedule should be formulated for the entire recovery/ mitigation effort. Figure 13 provides a general description of the schedule of activities that should be established.

Notify Property Owners of Damage and Repair Requirements.

Damage information should also be supplied to all property owners along

with information regarding permit and other requirements for making temporary or permanent repairs or for rebuilding structures that were destroyed. The property owners should also be notified of the building moratorium if it has been imposed by the Mayor and City Council. Notification of property owners will be especially important in Ocean City since many owners do not occupy the property or live on the island.

Lift Moratorium on Minor Repairs.

Minor repairs can either be exempted from the temporary building moratorium or the moratorium on these repairs should be lifted within a few days. In general, any repairs that would not ordinarly require a building permit should be exempted from the moratorium. Other minor repairs that are needed to make the building safe for occupancy or use should be permitted as soon as procedures have been established for inspecting the buildings and issuing the permits.

Evaluate Hazards and the Effectiveness of Mitigation Policies.

Based on information from the damage assessment, damage survey reports and additional investigations, City officials should evaluate the hazard situation that exists following the disaster. Flooding, and particularly erosion, may have substantially changed hazard areas from what they were before the disaster. A survey of the oceanfront should be performed, to determine the distance between MHW and the Building Limit Line. Areas of overwash should be carefully examined for erosion and increase in breaching potential. Bayside areas should be examined for erosion and damage to bulkheads and canals.

If the initial survey indicates that erosion of the beach and other portions of the barrier has changed the topography significantly, then a new flood hazard area study should be commissioned immediately. This new identification of flood hazard areas will be critical to decisions

on issuing permits for reconstruction of buildings with damage greater than 50 percent of market value, for permitting new development and for relocating the Building Limit Line.

There should also be a careful inspection of all buildings that sustained significant damage as well as many of those that sustained little or no damage. These inspections should help to identify if the building codes and other building regulations presently in force are adequate or should be changed. Specific items that should be examined include: how foundations held up to erosion and scour; how much damage was suffered from high winds; the adequacy of connections within buildings; performance of floodproofing; how well different materials withstood the effects of the storm; the influence of building design and placement on lots on overwash and erosion between buildings.

Lift Moratorium for Major Repairs to Conforming Structures.
Major repairs to structures that were conforming prior to the disaster and will not be made nonconforming by changes to the BLL, building code or other regulations can be lifted as soon as the procedures for inspection and permitting are in place and the permitting of minor repairs is proceeding smoothly.

Revise Codes and Policies.
Based on these evaluations, both the State and City should modify policies, regulations, codes, and other regulatory measures as needed to improve their effectiveness in reducing storm damages. The Disaster Recovery Task Force should play a major role in reviewing potential changes and recommendations for improvements in existing measures.

Initiate Negotiations for Relocations and Acquisitions.
As a result of erosion, changes in the flood hazard, movement of the BLL, and changes in other measures to reduce the potential for future

flood losses, it may be advisable to acquire some properties. The Property Acquisition Advisory Committee should evaluate all properties that may pose a hazard for redevelopment and make recommendations as to whether they should be acquired by the City.

Lift Moratorium on Major Repairs for Nonforming Properties.
After the major decisions on mitigation measures have been made, such as relocation of the BLL, changes in the building code, and proposed acquisition of properties have been made, decisions can be made on whether to permit repair or reconstruction of those properties with major damage that are now (or were before the disaster) nonconforming.

Lift Moratorium on New Development.
After procedures for all other aspects of the recovery have been established, the moratorium on new development may be lifted.

BEACH AND DUNE RESTORATION

Immediately following a coastal storm, emergency debris removal (i.e., the sand which was moved from the beach across the barrier) will be necessary to restore mobility within the city. Removal and redistribution of sand will begin to occur on individual properties as owners begin to restore "things to the way they used to be." Unless some control of this emergency and recovery effort is planned, there may be some costly, unnecessary and environmentally harmful actions. A Post-Disaster Recovery/Mitigation Plan needs to identify what is emergency versus recovery debris removal, what actions will have short- versus long-term results and which areas should receive more sand than others. If the plan is geared for the response to a major event (i.e., 100-year storm), most impacts will be addressed. A storm of a higher frequency (e.g., 10-year) and less impact (e.g., minor overwash) would not require as much use of the plan. Removal of sand from the Coastal

Highway will be a major issue following a 100-year storm, but not even a consideration after a minor nor'easter.

The following is a list of general criteria, procedures and actions to take following a major storm. They are listed in order of importance. The emphasis is placed on proper use of overwash sand, assessment of natural changes and attention to performance of shoreline protection structures (i.e., groins). The primary objective is: use the impact of a disaster to achieve longer term beach and dune protection while abandoning efforts that only provide interim beach protection. Any reference to "groins", below, infers the newer groins built to proper engineering standards (post 1982).

Emergency Response (within the first two weeks) After The Storm. Priority attention must be given to the placement of sand in areas that are critically vulnerable to post-storm changes (e.g., breaches where new inlets may form). Overwash during subsequent high tides must be controlled.

1. Make aerial reconnaissance to collect immediate photo documentation and to identify critical areas.
2. Fill any breaches or overwash channels that cross the island beginning in the center of the island and working in opposite directions --eastward toward the ocean and westward toward the bays. Use the nearest available sand, which may include some other debris (e.g., matresses, concrete blocks, wood siding etc.)
3. Fill any remaining gaps or particularly low areas along the dune front with the nearest sand and other debris.

After the physical integrity of the barrier has been restored, remove sand from public roads only to provide for the necessary access and mobility that will allow for other emergency and recovery actions.

1. Clear sand and other debris from the Coastal Highway and stock- pile along the shoulders.
2. Clear sand and other debris from streets perpendicular to and east of the Coastal Highway and move it toward the ocean. Sand maybe placed on the beach at the street ends, but should be cleaned of any other debris.
3. Clear sand and other debris from any cross-streets east of the Coastal Highway and stockpile along shoulders.
4. Clear sand and other debris from streets perpendicular and west of the Coastal Highway and stockpile along shoulders.

After mobility along public roads has been improved, redistribute clean sand (i.e., all other debris removed) from shoulders of roads to the beach so that erosion and flood control is improved.

1. Move clean sand from the street ends along the upper portions of the beach. No bulldozing of sand from lower portions of the beach should occur.
2. Move enough stockpiled sand from cross-street shoulders to the nearest street end so that it may also be used along the upper beach. Remove other debris before placing sand on beach.
3. Hold other stockpiled sand in place or stockpile in more appropriate location on the block. This sand may not be used for a month or more.

This emergency response insures adequate short-term protection to beachfront property while providing more time for implementation of longer term recovery actions.

Recovery Actions (two to six weeks after the storm).

An inventory of the natural changes to beach and dune areas and damages to shoreline protection structures will provide a basis for prioritizing action as well as allowing post-storm recovery of the beach to occur naturally.

1. Visually observe, from ground level, beach elevations within the groin cells and beach elevations in areas without groins. Use the graduated staffs for observations and document changes respectively.
2. Observe and record any differences in beach position on either side of the existing groins.
3. Observe and record changes that occurred to dunes noting any obvious damage that may have resulted from nearby groins, seawalls or other structures.
4. Inspect and document the condition of publc shoreline protection structures (i.e., groins, bulkheads and seawalls). This will be done as part of a Damage Survey Report; these structures may be eligible for disaster relief.
5. Inventory the bay shoreline for natural changes as a result of overwash and possible erosion which might indicate barrier narrowing. After the post-storm status of the beach and dune protection has been documented, assess the changes that have occurred and prioritize the areas to receive action.

1. Restore beach areas located between groins (cells) so they meet the capacity fill requirements, and correct any downdrift erosion problems with sand fill.
2. Restore beach areas without groins so that a consistent beach height and width along the shoreline is established.
3. Reestablish any dunes existing prior to the storm if the beach is wide enough to support them.
4. Establish dunes in areas where the beach has been widened enough to support them.
5. Repair any shoreline protection structures that were damaged and determined not to be the cause of any adverse impact to adjacent beach or dune areas. The following priorities should be established given possible economic limitations:

a. Groins built to engineering standards;
b. Bulkheads or seawalls between North Division and 27th Streets; and,
c. Publicly owned bulkheds or seawalls north of 27th Street.

6. Remove, not repair, any damaged shoreline protection structures determined to be the cause of adverse impact to adjacent beach or dune areas. Consider replacement of seawalls and bulkheads that are used as foundations and incorporate flow-through design features.

After an assessment of damages and priority of actions has been established, select a low-cost solution which will address the required action and may also mitigate any future damages. The following list is neither in order of importance nor necessarily complete.

1. Utilize overwash sands from cross-streets;
2. Utilize sand from groin cells that are filled over capacity;
3. Locate and utilize other sand sources;
4. Construct sand fences and initiate dune vegetation;
5. Redesign, while repairing, damaged groins to changed beach configuration;
6. Relocate position for future groins, but do not install any less than two per area so that the cell can be filled to capacity; and,
7. Abandon plans for future groins if present groins are found to be ineffective.

Long-Term Planning (beyond six weeks after the storm): Documentation of the sum changes that occurred on the coastal barrier as a result of the storm event, emergency response and recovery action will provide a basis for updating hazard vulnerability, storm and beach protection plans and hazard mitigation opportunities.

1. Conduct a vertical aerial photo survey which meets the standards applied in 1980 by Greenhorne and O'Mara, Inc.
2. Conduct a post-disaster planning study similar to this.

3. Incorporate additional recommendations for scientific research listed in Appendix D.

LIST OF REFERENCES

Barrier Island Forum and Workshop, Provincetown, Massachusetts, 1980. B. Mayo and L. B. Smith, eds. Boston office, U.JS. National Park Service, 107p.

Barrier Islands and Beaches, 1976. Technical Proceedings to the Barrier Islands Workshop, Annapolis, Maryland;· Conservation Foundation.

Dean, Robert G. and M. Perlin, 1977. Coastal engineering study of Ocean City Inlet, Maryland; in Proceedings to Coastal Sediments 1977, ASCE., pp.520-542.

Dolan, Robert et al, 1980. Geographical analysis of Fenwick Island, Maryland, a middle Atlantic coast barrier island; USGS professional paper 1177-A, Washington, D.C.

Farrell, Stewart and John Sinton, 1983. Post-Storm Planning for Avalon, N.J. Prepared for the New Jersey Department of Environmental Protection, Division of Coastal Resources.

Federal Emergency Management Agency and Office of Ocean and Coastal Resource Management, U.S. Department of Commerce, NOAA, 1983. Preparing for Hurricanes and Coastal Flooding: A Handbook for Local Officials. Prepared by Ralph M. Field Associals.

Federal Emergency Management Agency and U.S. Department of Housing and Urban Development, 1981. Design and Construction Manual for Residential Buildings in Coastal High Hazard Areas. Document # FIA-7/January 1981Fisher, J. J., 1977. Coastal erosion revealed; Geotimes v.22, p.24-25.

Flood Insurance Study, Worcester County, Maryland, 1982. Federal Emergency Management Agency, Region III, Philadelphia, Pennsylvania.

Goldsmith, Victor, 1974. W. D. Norris, R. J. Burns, J. W. Whitlock, 1974. Wave limate model of mid-atlantic shelf (Virginai Sea) VIMS, SRAMSO No. 38, Gloucester, VA. 148p.

Hayes, M. O. and Boothroyd, J. C., 1969. Storms as modifying agents in

the coastal environments; Field Trip Guidebook - Coastal Environments of Northestern Massachusetts and New Hampshire, Contribution No. 1 GRG, Geology Dept., of University of Mass., Amherst, MA. p.245-265.

Hayes, Miles O., 1979. Barrier island morphology as a function of tidal and wave regime; in Barrier Islands, S. Leatherman (ed.), Academic Press, Inc., New York, p.1-28.

Humphries, Stanley M. and Jeffrey R. Benoit, 1980. Barrier beach protection in Massachusetts; in Proceedings of Coastal Zone 80 Hollywood, Florida, November 1980.

Kerhin, Randy T. and H. P. Halka, 1981. Beach changes associated with bulldozing to the lower foreshore; Maryland Geol. Survey, Baltimore, MD, Open File Report No. 7, 28p.

Kusler, Jon A., 1982. Innovation in Local Floodplain Management: A Summary of Community Experience. Prepared for the U.S. Water Resource Council. Published by the Natural Hazards Research and Applications Information Center. Special Publication 4.

Leatherman, Stephen P., 1979. Migration of Assateague Island, Maryland, by inlet and overwash processes; Geology, v.7, p.104-107.

Leatherman, Stephen P., 1979. Barrier island handbook; University of Maryland, College Park, MD. 109p.

Leatherman, Stephen P., 1983. Shoreline mapping: A comparison of techniques; Shore and Beach, v.51, p.28-33.

McElyea, William; D., et al, 1982. Before the Storm: Managing Development to Reduce Hurricane Damages. Prepared for the Office of Coastal Management, Department of Natural Resources and Community Development by the Ocean and Coastal Policy Program Center for Urban and Regional Studies, University of North Carolina at Chapel Hill.

National Oceanic and Atmospheric Administration, 1983. Tides and currents along the east and atlantic coast of North Amearica.

Rogers, Golden & Halpern, 1981. Hurricane Evacuation and Hazard

Mitigation Study. Prepared for the City of Sanibel, Florida.

Slaughter, Turbit H., 1973. Regulatory aspects relative to coastal management problems, Ocean City, Maryland's Atlantic coast Beach; Shore and Beach, v.41.

Sonu, C. J., 1968. Collective movement of sediment in littoral environment; in Procedings of the 11th Conference on Coastal Engineering, A.S.C.E., London, England, v.1, p.373-400.

Titus, James G. et al, 1983. Sea level rise overview paper; U.S. Environmental Protection Agency, Washington, D.C.

Trident Engineering Associates, Inc., 1979. Interim beach maintenance at Ocean City; prepared for the Energy and Coastal Administration, Department of Natural Resources, State of Maryland, Annapolis, MD.

Truitt, R. V. 1968. High winds and high tides, Natural Resources Institute, Series No.77, Universilty of Maryland.

University of Georgia, Institute of Community and Area Development, 1983. Jekyll Island Comprehensive Land Use Plan.

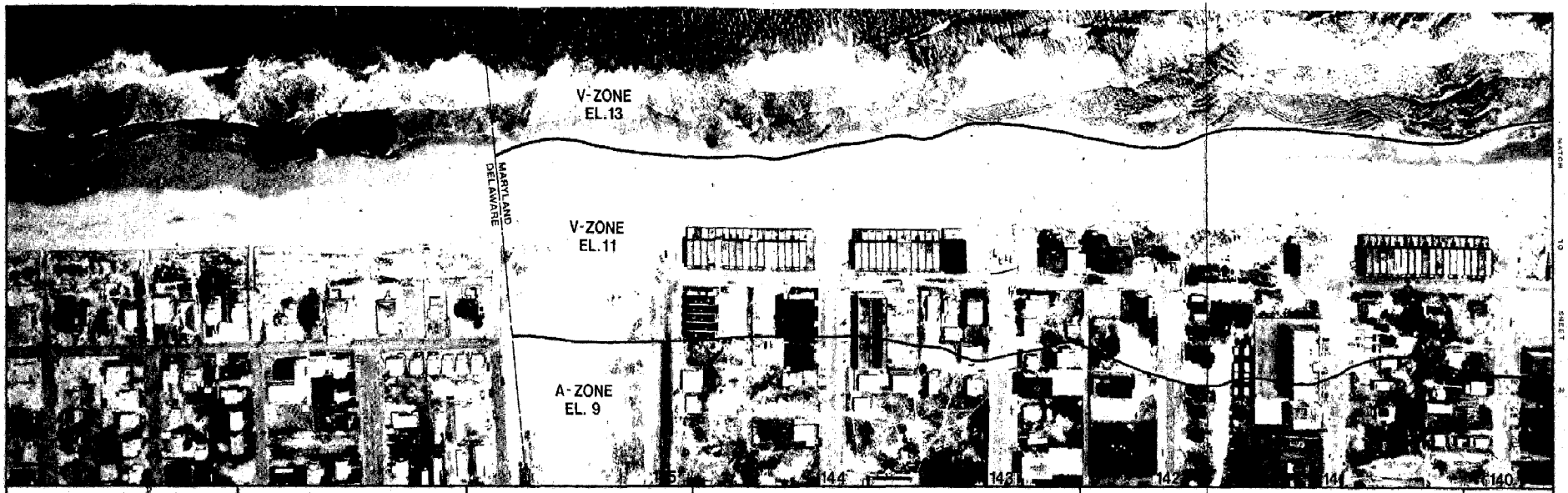
U.S. Army Corps of Engioneers, Baltimore District, 1962. Operation five-high: disaster recovery operations from 6-8 March; 1962 storm under Public Law 875, 81 Congress. Baltimore, MD.

U.S. Army Corps of Engineers, Coastal Engineering Research Center, 1977. Shore protection manual; U.S. Army Corps of Engineers, Superintendent of Documents, Washington, D.C., 3 vols.

U.S. Army Corps of Engineers, Baltimore District, 1980. Atlantic coast of Maryland and Assateaque Island, Virginia: feasibility report and final environmentl impact statement; Baltimore, MD.

APPENDIX A

1981 Photogrammetric Survey of the Beach Control District
and
Approximate Location of the Oceanfront Flood Insurance Zones (1983 FIRM)



SCALE 1" = 100'

CONTOUR INTERVAL: DATUM: Mean Low Water
MARYLAND STATE PLANE GRID
Mapping is certified to meet or exceed National Map Accuracy Standards
Dashed contours may not meet N.M.A.S.

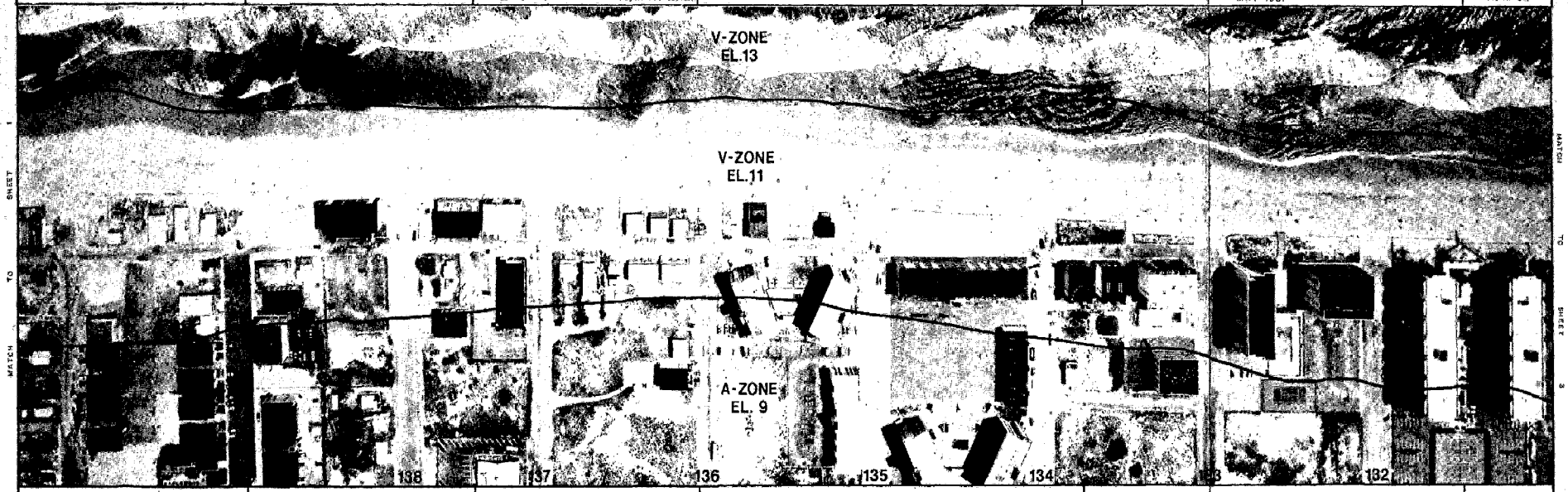
Bernard W. Solomon (Date) 7-24-82
BERNARD W. SOLOMON Certified Photogrammetrist 385 ASP

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION
COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY
BEACH EROSION CONTROL DISTRICT
DELAWARE STATE LINE TO THE OCEAN CITY INLET
OCEAN CITY, MARYLAND
MAY 1981

SHEET NO. 1
FROM MD/DEL. St.Line
TO 140 TH ST.

MATCH TO SHEET 2



SCALE 1" = 100'

CONTOUR INTERVAL: DATUM: Mean Low Water
MARYLAND STATE PLANE GRID
Mapping is certified to meet or exceed National Map Accuracy Standards.
Dashed contours may not meet N.M.A.S.

Bernard W. Solomon (Date) 7-24-82
BERNARD W. SOLOMON Certified Photogrammetrist 385 ASP

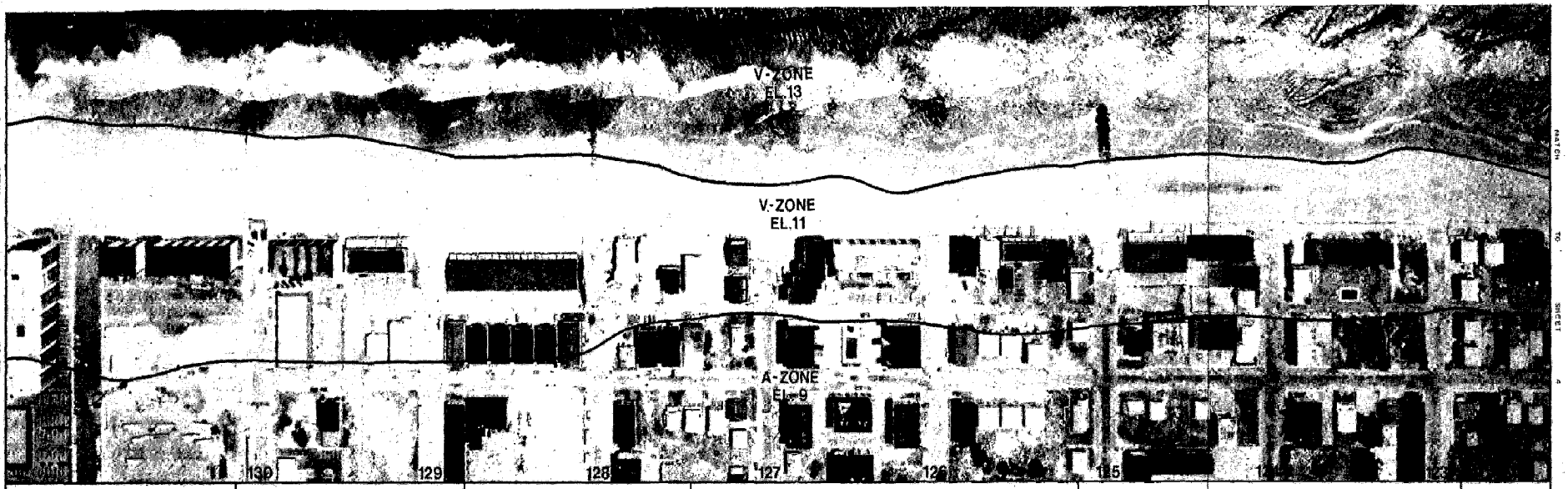
STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION
COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY
BEACH EROSION CONTROL DISTRICT
DELAWARE STATE LINE TO THE OCEAN CITY INLET
OCEAN CITY, MARYLAND
MAY 1981

SHEET NO. 2
FROM 139 TH ST.
TO 132 ND ST.

MATCH TO SHEET 3

PREPARED BY GREENHORNE & O'MARA INC from photography dated May 3, 1981



SCALE 1"=100'

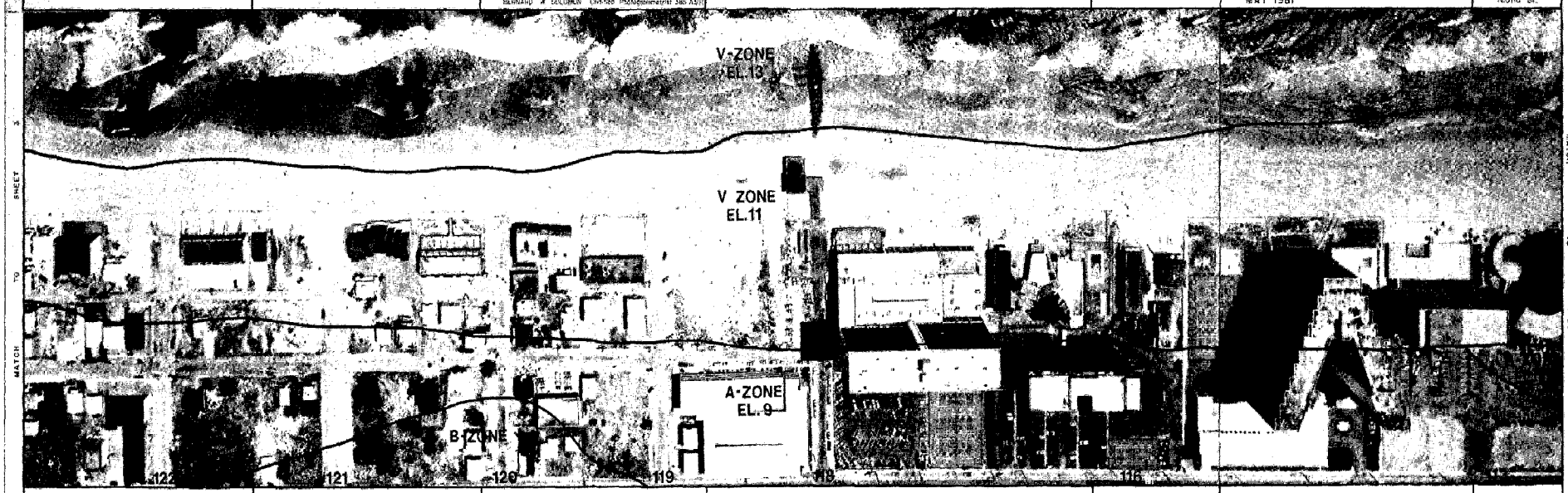
CONTOUR INTERVAL DATUM: Mean Low Water
MARYLAND STATE PLANE GRID
Mapping is certified to meet or exceed National Map Accuracy Standards
Dashed contours may not meet N.M.A.S.

Bernard W Solomon (Date) 3-24-82
BERNARD W. SOLOMON Certified Photogrammetrist 385 ASP

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION
COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY
BEACH EROSION CONTROL DISTRICT
DELAWARE STATE LINE TO THE OCEAN CITY INLET
OCEAN CITY, MARYLAND
MAY 1981

SHEET NO. 3
FROM 131ST ST.
TO 123RD ST.



SCALE 1"=100'

CONTOUR INTERVAL DATUM: Mean Low Water
MARYLAND STATE PLANE GRID
Mapping is certified to meet or exceed National Map Accuracy Standards
Dashed contours may not meet N.M.A.S.

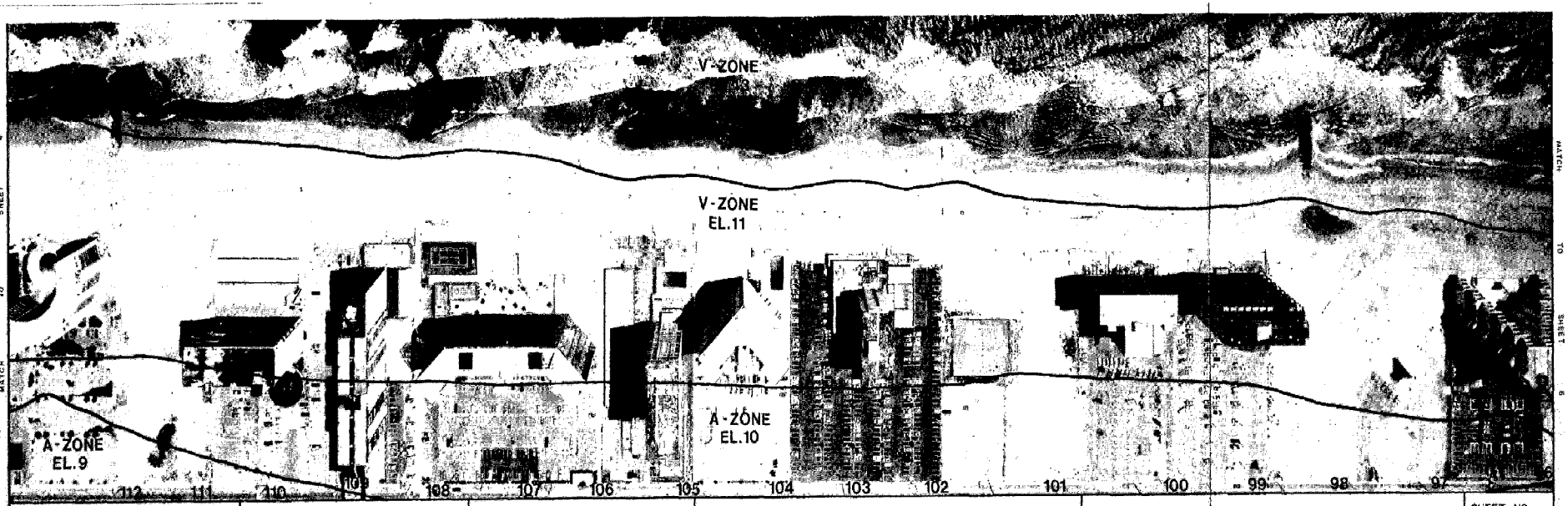
Bernard W Solomon (Date) 3-24-82
BERNARD W. SOLOMON Certified Photogrammetrist 385 ASP

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION
COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY
BEACH EROSION CONTROL DISTRICT
DELAWARE STATE LINE TO THE OCEAN CITY INLET
OCEAN CITY, MARYLAND
MAY 1981

SHEET NO. 4
FROM 122ND ST.
TO 113TH ST.

PHOTOGRAPHY TAKEN FROM PHOTOGRAPHY FLOWN MAY 5, 1981



SCALE 1"=100'

CONTOUR INTERVAL DATUM: Mean Low Water

MARYLAND STATE PLANE GRID

Mapping is certified to meet or exceed National Map Accuracy Standards

Dashed contours may not meet N.M.A.S.

Bernard W Solomon (Date) 9-24-82

BERNARD W. SOLOMON Certified Photogrammetrist 385 A.S.P.

STATE OF MARYLAND

DEPARTMENT OF NATURAL RESOURCES

TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION

COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY

BEACH EROSION CONTROL DISTRICT

DELAWARE STATE LINE TO THE OCEAN CITY INLET

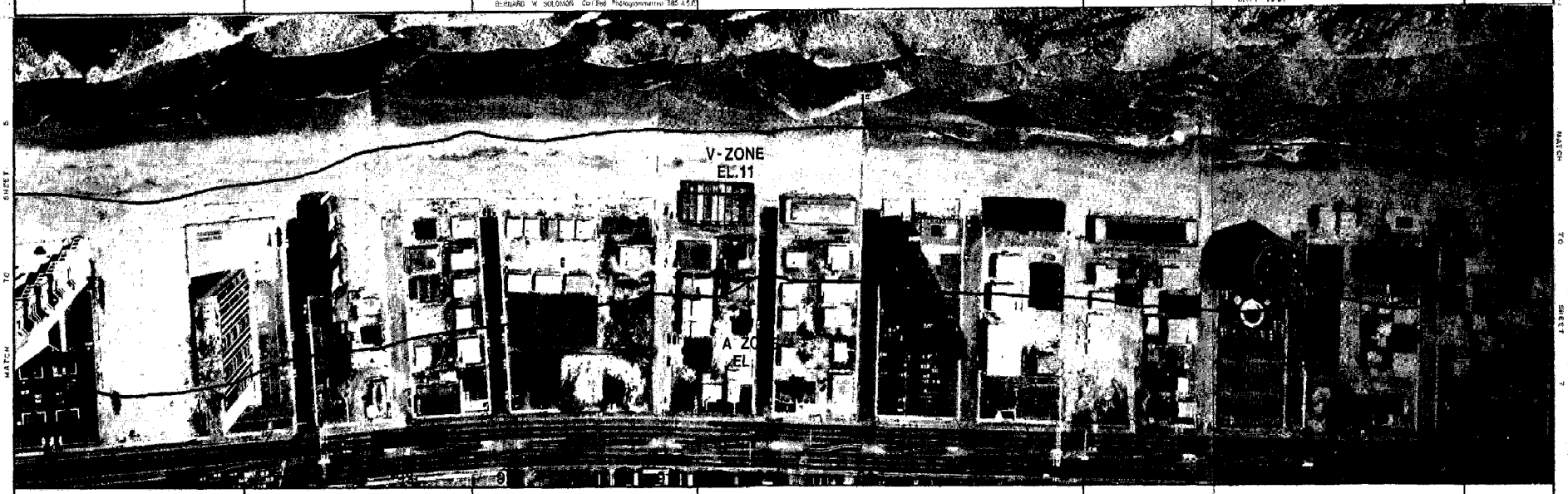
OCEAN CITY, MARYLAND

MAY 1981

SHEET NO. 5

FROM 112 TH ST

TO 97 TH ST



SCALE 1"=100'

CONTOUR INTERVAL DATUM: Mean Low Water

MARYLAND STATE PLANE GRID

Mapping is certified to meet or exceed National Map Accuracy Standards

Dashed contours may not meet N.M.A.S.

Bernard W Solomon (Date) 9-24-82

BERNARD W. SOLOMON Certified Photogrammetrist 385 A.S.P.

STATE OF MARYLAND

DEPARTMENT OF NATURAL RESOURCES

TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION

COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY

BEACH EROSION CONTROL DISTRICT

DELAWARE STATE LINE TO THE OCEAN CITY INLET

OCEAN CITY, MARYLAND

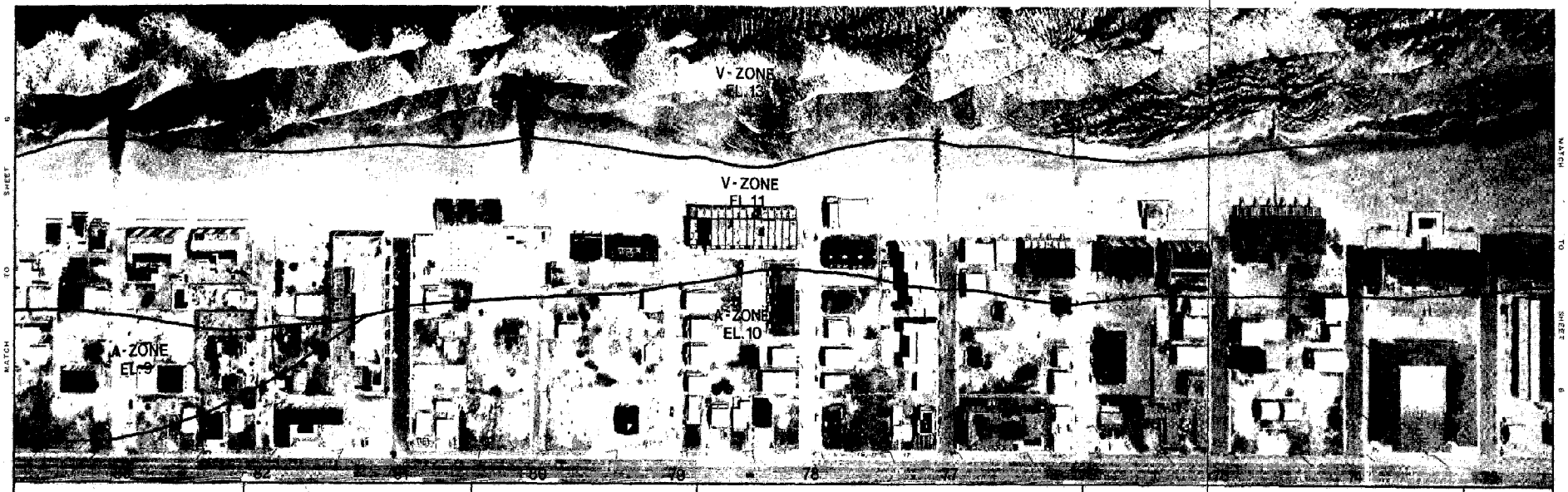
MAY 1981

SHEET NO. 6

FROM 96TH ST.

TO 84TH ST.

PREPARED BY GREENHORNE & O'MARA INC from photography dated May 3, 1981



SCALE 1"=100'

CONTOUR INTERVAL DATUM Mean Low Water

MARYLAND STATE PLANE GRID

Mapping is certified to meet or exceed National Map Accuracy Standards

Dashed contours may not meet NMAS

Bernard W. Solomon (Date) 3-24-82

BERNARD W. SOLOMON Certified Photogrammetrist 385 ASP

STATE OF MARYLAND

DEPARTMENT OF NATURAL RESOURCES

TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION

COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY

BEACH EROSION CONTROL DISTRICT

DELAWARE STATE LINE TO THE OCEAN CITY INLET

OCEAN CITY, MARYLAND

MAY 1981

SHEET NO. 7

FROM 83RD ST.

TO 73RD ST.

SCALE 1"=100'

CONTOUR INTERVAL DATUM Mean Low Water

MARYLAND STATE PLANE GRID

Mapping is certified to meet or exceed National Map Accuracy Standards

Dashed contours may not meet NMAS

Bernard W. Solomon (Date) 3-29-82

BERNARD W. SOLOMON Certified Photogrammetrist 385 ASP

STATE OF MARYLAND

DEPARTMENT OF NATURAL RESOURCES

TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION

COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY

BEACH EROSION CONTROL DISTRICT

DELAWARE STATE LINE TO THE OCEAN CITY INLET

OCEAN CITY, MARYLAND

MAY 1981

SHEET NO. 8

FROM 73RD ST.

TO 63RD ST.

PREPARED BY DEWBERRY & DAVIS INC. from photography dated May 3, 1981

SCALE 1" = 100'

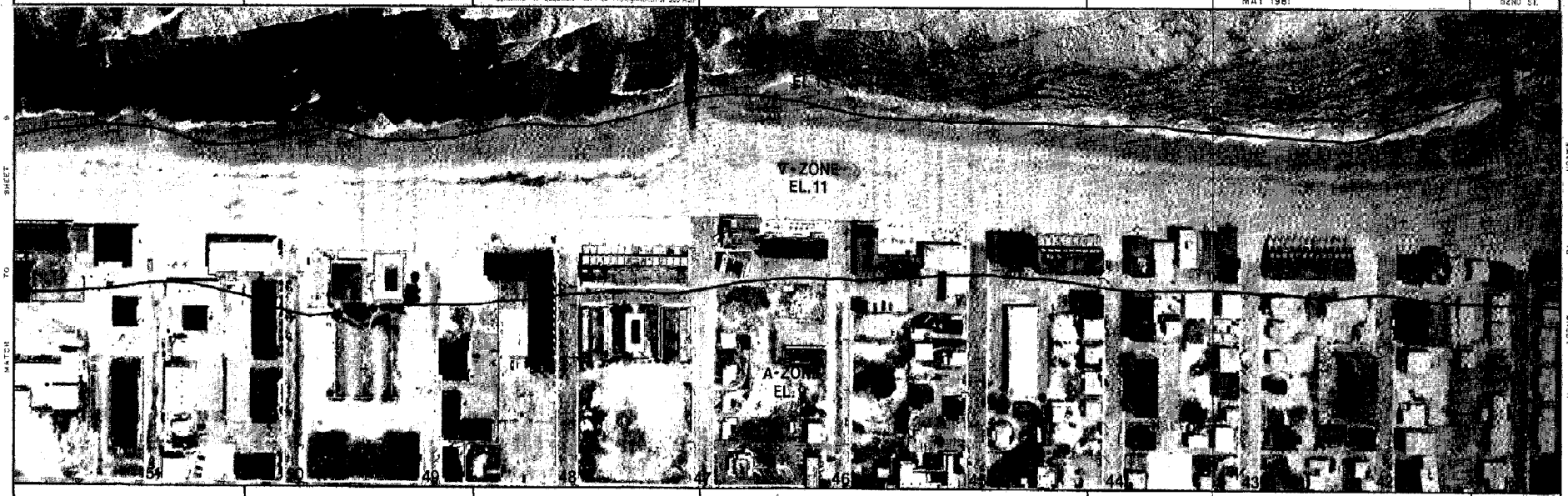
CONTOUR INTERVAL DATUM: Mean Low Water
MARYLAND STATE PLANE GRID
Mapping is certified to meet or exceed National Map Accuracy Standards
Dashed contours may not meet N.M.A.S.

Bernard W. Solomon (Date) 3-24-82
BERNARD W. SOLOMON Certified Photogrammetrist 385 A.S.P.

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION
COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY
BEACH EROSION CONTROL DISTRICT
DELAWARE STATE LINE TO THE OCEAN CITY INLET
OCEAN CITY, MARYLAND
MAY 1981

SHEET NO. 9
FROM 62ND ST.
TO 52ND ST.



SCALE 1" = 100'

CONTOUR INTERVAL DATUM: Mean Low Water
MARYLAND STATE PLANE GRID
Mapping is certified to meet or exceed National Map Accuracy Standards
Dashed contours may not meet N.M.A.S.

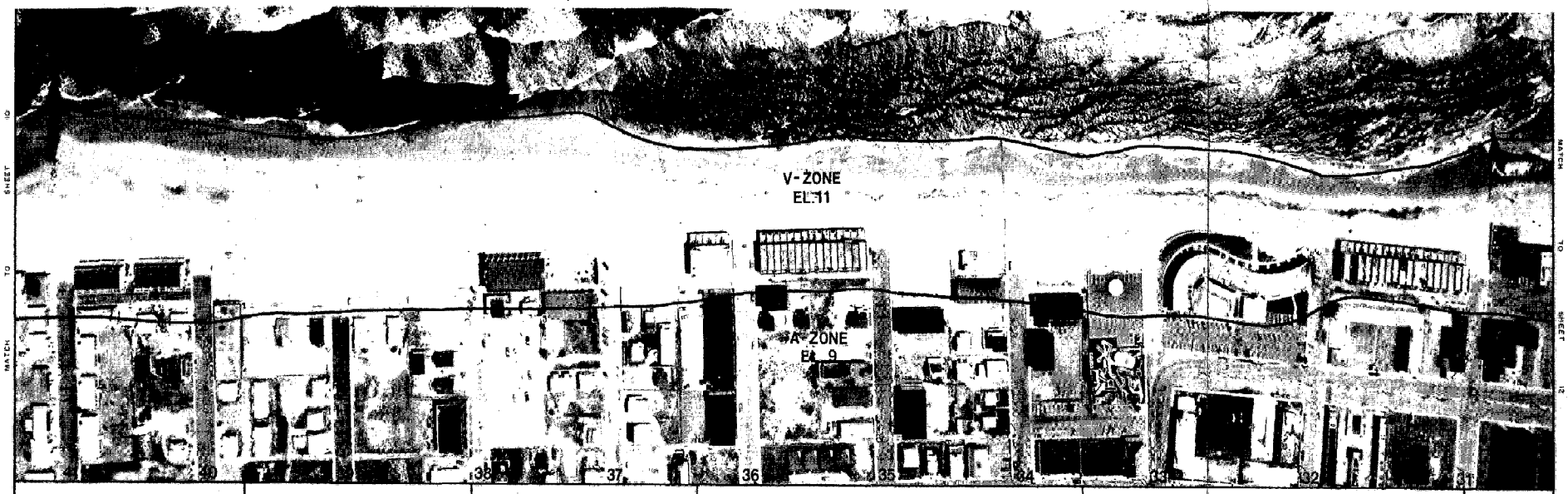
Bernard W. Solomon (Date) 3-24-82
BERNARD W. SOLOMON Certified Photogrammetrist 385 A.S.P.

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION
COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY
BEACH EROSION CONTROL DISTRICT
DELAWARE STATE LINE TO THE OCEAN CITY INLET
OCEAN CITY, MARYLAND
MAY 1981

SHEET NO. 10
FROM 51 ST. ST.
TO 41 ST. ST

COMPILED BY GREENHORNE & O'MARA, INC. from photography dated May 3, 1981



SCALE 1"=100'

CONTOUR INTERVAL: DATUM: Mean Low Water
MARYLAND STATE PLANE GRID
Mapping is certified to meet or exceed National Map Accuracy Standards.
Dashed contours may not meet N.M.A.S.

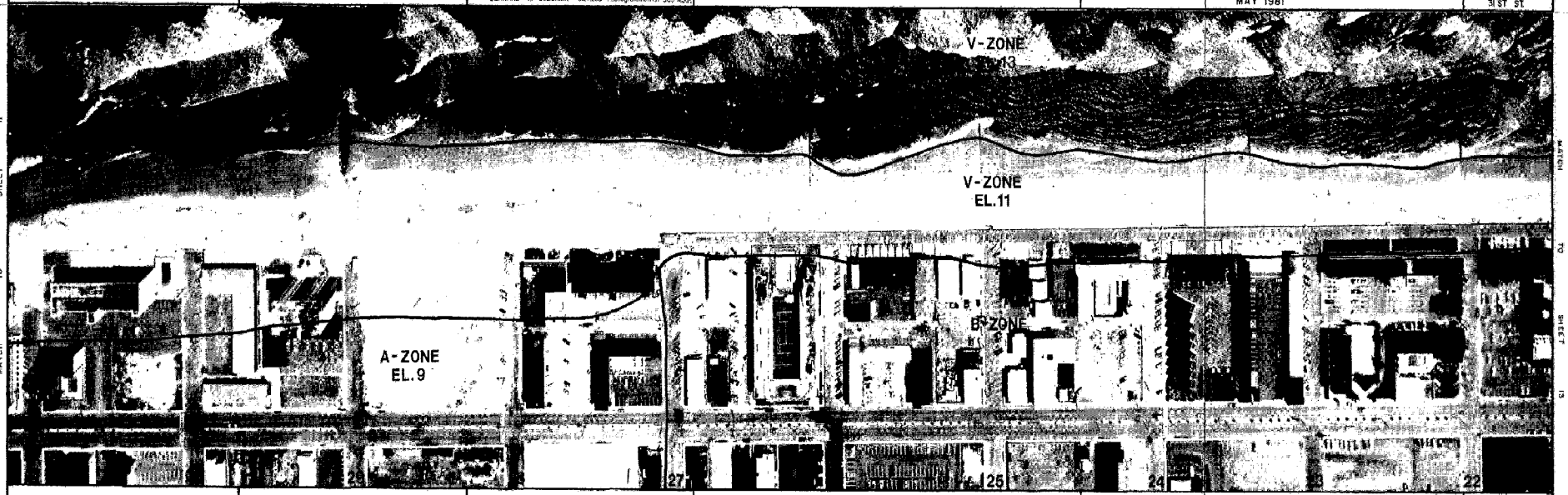
Bernard W. Solomon (Date) 3-24-82
BERNARD W. SOLOMON Certified Photogrammetrist 385 ASP

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION
COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY
BEACH EROSION CONTROL DISTRICT
DELAWARE STATE LINE TO THE OCEAN CITY INLET
OCEAN CITY, MARYLAND
MAY 1981

SHEET NO. 11
FROM: 41 ST. ST.
TO: 31 ST. ST.

MATCH SHEET 10 TO SHEET 12



SCALE 1"=100'

CONTOUR INTERVAL: DATUM: Mean Low Water
MARYLAND STATE PLANE GRID
Mapping is certified to meet or exceed National Map Accuracy Standards.
Dashed contours may not meet N.M.A.S.

Bernard W. Solomon (Date) 3-24-82
BERNARD W. SOLOMON Certified Photogrammetrist 385 ASP

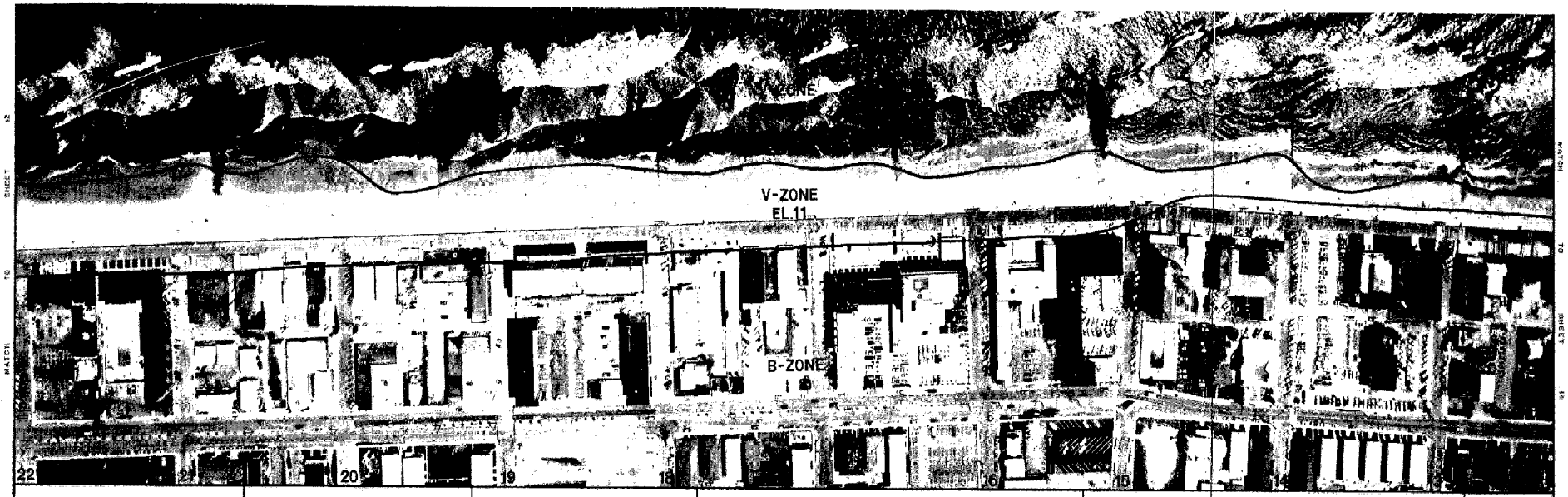
STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION
COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY
BEACH EROSION CONTROL DISTRICT
DELAWARE STATE LINE TO THE OCEAN CITY INLET
OCEAN CITY, MARYLAND
MAY 1981

SHEET NO. 12
FROM: 30 TH ST.
TO: 22 ND ST.

MATCH SHEET 11 TO SHEET 13

PREPARED BY GREENHORNE & O'MARA INC. from photography taken May 9, 1981



SCALE 1"=100'

CONTOUR INTERVAL: DATUM: Mean Low Water
MARYLAND STATE PLANE GRID

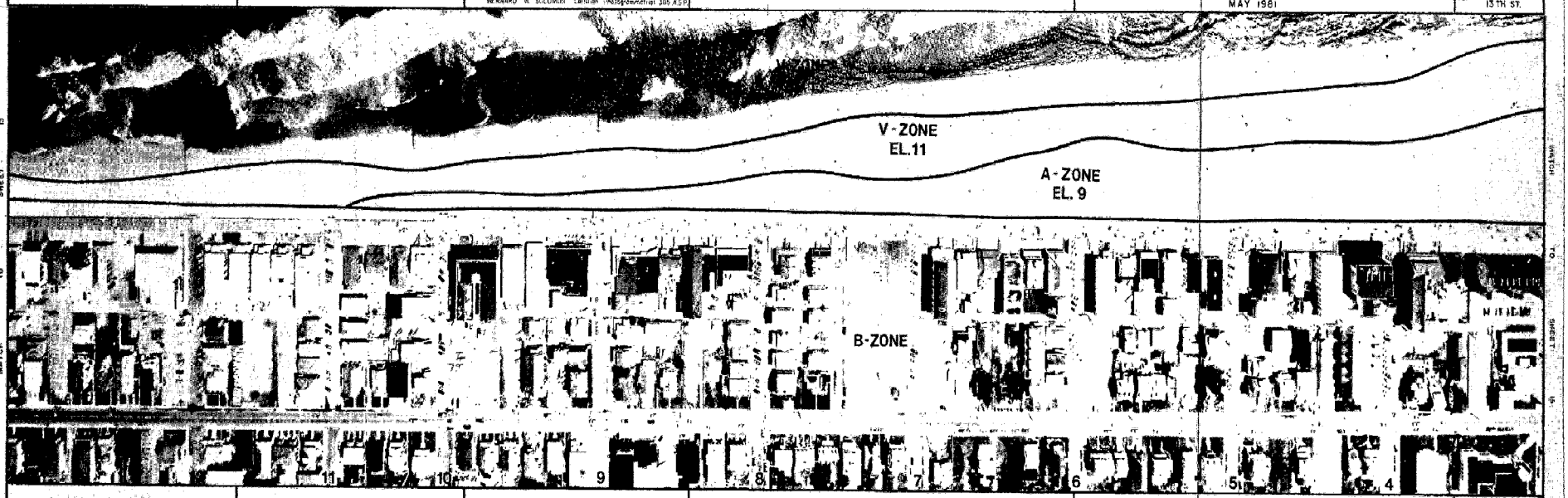
Mapping is certified to meet or exceed National Map Accuracy Standards.
Dashed contours may not meet N.M.A.S.

Bernard W. Solomon (Date) 2-24-82
BERNARD W. SOLOMON Certified Photogrammetrist 385 A.S.P.

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION
COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY
BEACH EROSION CONTROL DISTRICT
DELAWARE STATE LINE TO THE OCEAN CITY INLET
OCEAN CITY, MARYLAND
MAY 1981

SHEET NO. 13
FROM: 21ST ST.
TO: 13TH ST.



SCALE 1"=100'

CONTOUR INTERVAL: DATUM: Mean Low Water
MARYLAND STATE PLANE GRID

Mapping is certified to meet or exceed National Map Accuracy Standards.
Dashed contours may not meet N.M.A.S.

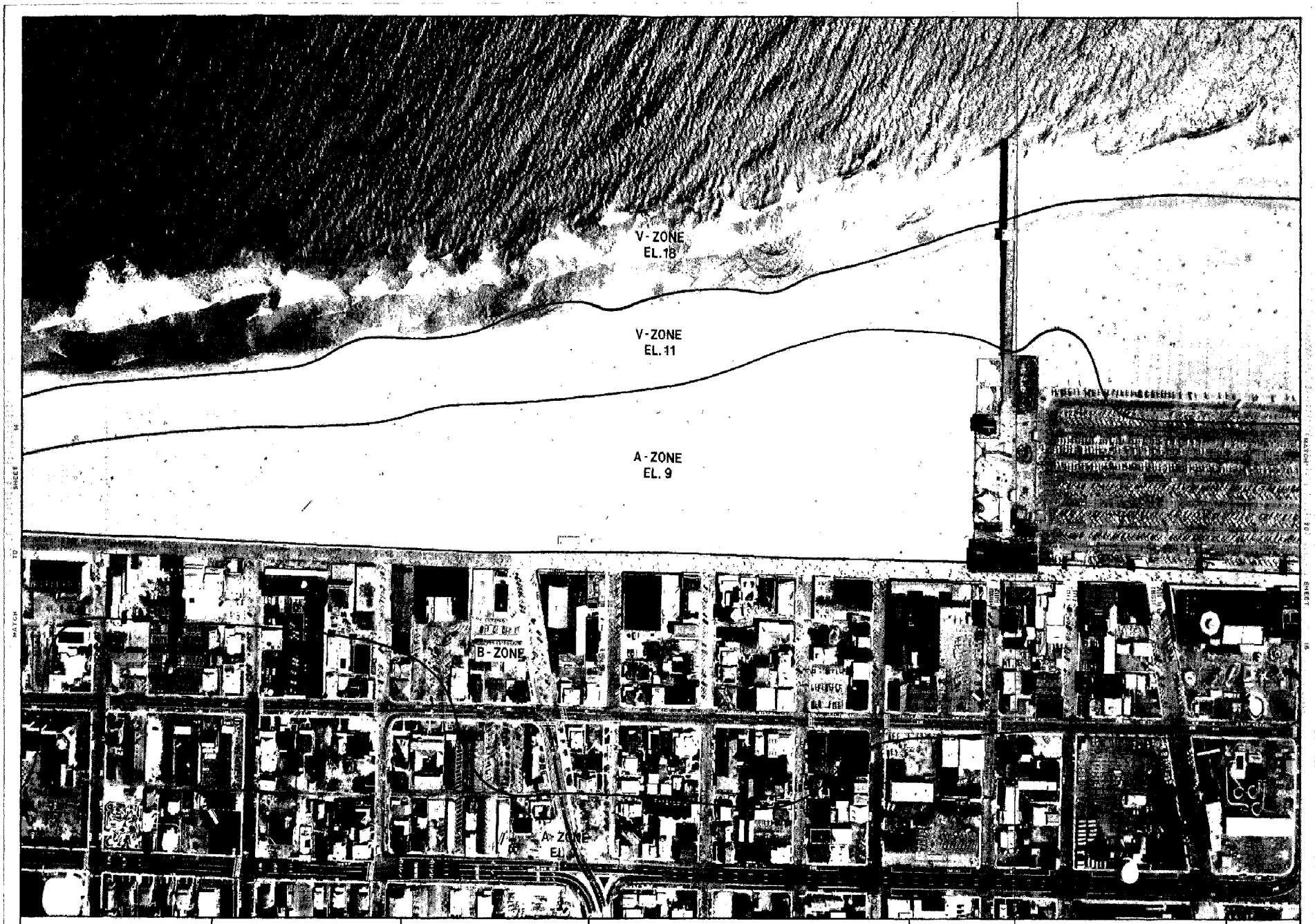
Bernard W. Solomon (Date) 2-24-82
BERNARD W. SOLOMON Certified Photogrammetrist 385 A.S.P.

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION
COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY
BEACH EROSION CONTROL DISTRICT
DELAWARE STATE LINE TO THE OCEAN CITY INLET
OCEAN CITY, MARYLAND
MAY 1981

SHEET NO. 14
FROM: 12TH ST.
TO: 4TH ST.

PHOTOGRAPHED BY GREENHORNE & O'MARA INC. final photography dated May 3, 1981



MATCH SHEET 14

MATCH SHEET 16

SCALE 1:100

CONTOUR INTERVAL DATUM Mean Low Water

MARYLAND STATE PLANE GRID

Mapping is certified to meet or exceed National Map Accuracy Standards

Dashed contours may not meet N.M.A.S.

Bernard W. Solomon (Date) 3-29-82

BERNARD W. SOLOMON Certified Photogrammetrist 260 A.S.P.

STATE OF MARYLAND

DEPARTMENT OF NATURAL RESOURCES

TIDEWATER ADMINISTRATION — CAPITAL PROGRAMS ADMINISTRATION

COASTAL ZONE DIVISION — SHORE EROSION CONTROL PROGRAM

AERIAL PHOTOGRAPHY

BEACH EROSION CONTROL DISTRICT

DELAWARE STATE LINE TO THE OCEAN CITY INLET

OCEAN CITY, MARYLAND

MAY 1981

SHEET NO. 15

FROM 3RD ST

TO S OCEAN ST

DERIVED BY STEREOSCOPIC COMPILATION from photography dated May 5, 1981

APPENDIX B

Federal Role in Emergency Response and Procedures for Obtaining Federal Disaster Assistance

THE FEDERAL ROLE IN EMERGENCY RESPONSE AND PROCEDURES FOR OBTAINING FEDERAL DISASTER ASSISTANCE[1]

Federal disaster assistance programs are designed to supplement local, state, and private resources when these are insufficient to repair damages and to alleviate hardship in the wake of a major disaster. The key federal legislation dealing with disasters is the Disaster Relief Act of 1974 (P.L. 93-288), which authorizes a wide range of financial and direct assistance to state and local governments and private individuals. While other legislation has created a number of disaster assistance programs within a variety of federal agencies, the Disaster Relief Act and the regulations adopted to administer it set the guidelines and procedures by which federal aid is issued and vests the Federal Emergency Management Agency with primary responsibility for coordinating and providing disaster relief. FEMA follows standard set of procedures governing federal responsibilities, damage assessments, applications for assistance, the granting of assistance, and post-disaster hazard mitigation planning.

THE PRESIDENTIAL DECLARATION

FEMA's disaster response procedures are set into motion by a Presidential declaration of "emergency" or "major disaster," as authorized by P.L. 93-288. An "emergency" is any natural disaster which calls for emergency federal assistance to supplement stateand local efforts to avert the threat of a disaster or to protect lives, public health, and property. A "major disaster" is one that causes damages of a sufficient severity and magnitude to warrant major federal assistance above and beyond emergency services.

FEMA keeps close track of potential disasters, such as the development and path of a hurricane; it maintains close contact with the Governor's office and the Maryland Emergency Management and Civil Defense Agency, as well as other federal agencies responsible for disaster assistance, as the threat increases and disaster strikes. After an initial reconnaissance, local officials in a disaster-striken community should immediately report the nature and extent of damages to the Maryland Emergency Management and Civil Defense Agency (EMCDA). EMCDA then advises the Governor on the seriousness of the situation; the Governor may declare a state of emergency, put the state's disaster assistance plan into operation, and direct state resources to where they are needed. If it becomes apparent that the situation is of a severity or magnitude that exceeds state and local capabilities, the Governor can ask the President, via FEMA, to declare an "emergency" or "major disaster." Only the Governor (or Acting Governor) can make this request.

---

[1]*This section is adapted, with only minor changes, from* Before the Storm: Managing Development to Reduce Hurricane Damages. William D. McElyea, et. al., Ocean and Coastal Policy Program, Center for Urban and Regional Studies, University of North Carolina at Chapel Hill, Sept. 1982.

PRELIMINARY DAMAGE ASSESSMENT

If the Governor asks for a Presidential declaration, state disaster officials will:

1. survey the affected areas, jointly with local officials and (if possible) FEMA's regional disaster specialists, to determine the extent of damages;

2. estimate the types and extent of federal assistance needed;

3. consult with FEMA's Regional Director regarding eligibility requirements; and

4. advise FEMA's Regional Director of the state's intent to request a Presidential declaration.

The Governor's request for a Presidential declaration will include a certification of reasonable state and local expenditures for disaster relief and an estimate of the federal assistance required for the state and each affected county. The Governor's request, addressed to the President, is submitted to FEMA's Regional Director, who evaluates the estimates of damage and assistance needs and makes a recommendation to the Director of FEMA. The Director then recommends a course of action to the President, who issues the declaration and sets in motion the machinery for issuing federal disaster assistance to eligible public agencies, individuals, and businesses.

FEMA'S POST-DISASTER PROCEDURES

Once the President declares an "emergency" or "major disaster," the Governor and FEMA's Regional Director sign a Federal-State Disaster Assistance Agreement which specifies where and how federal disaster relief will become available. FEMA's Associate Director for Disaster Response and Recovery designates those counties and municipalities that are eligible for federal disaster assistance and appoints another federal official (usually FEMA's Regional Director) as the Federal Coordinating Officer (FCO). The FCO performs a number of functions:

1. determining the types of assistance most urgently needed;

2. coordinating all federal disaster relief efforts;

3. coordinating federal activities with those of state and local agencies and private disaster relief organizations (such as the Red Cross and the Salvation Army);

4. informing people in the community about the types of assistance available;

5. setting up and operating disaster field offices; and

6. taking other actions, consistent with his authority, to help local citizens and public agencies promptly obtain assistance for which they are eligible.

The FCO is usually supported by one or more deputies who are delegated to

perform some of these functions.

FEMA sets up a temporary Disaster Field Office in the stricken area as a base for federal disaster relief operations. The Disaster Field Office is usually located in conjunction with a similar state office operated by the State Coordinating Officer (from the Maryland Emergency Management and Civil Defense Agency), who is the primary liaison between the FCO and state and local officials. The location and telephone number of the Disaster Field Office is publicized widely to allow applicants to visit or call when problems arise. The Disaster Field Office is staffed by representatives of FEMA and all other federal agencies with disaster assistance responsibilities in the area. These field representatives are responsible for providing prompt assistance to disaster victims and advising local and state agencies on eligibility requirements, surveying and reporting damages, and applying for federal assistance. In addition to these agency representatives, the FEMA Regional Director may dispatch Emergency Support Teams to provide specialized counseling, to help operate the Disaster Field Office, and to temporarily supplement local and state emergency response and damage assessment efforts.

The types of federal disaster assistance fall into two general categories: individual assistance (for individuals, families, and businesses) and public assistance (for local and state agencies). FEMA disseminates information about available aid programs via local radio, television, newspapers, and pamphlets. FEMA will establish a Disaster Assistance Center in the area to help individual disaster victims more easily get information and guidance from the various federal agencies. FEMA may dispach mobile teams to help persons in the area who lack easy access to the Disaster Assistance Center. At the center, disaster victims apply for assistance from the various federal programs availble. In addition to operating the Disaster Assistance Center (mainly for providing individual assistance), FEMA and EMCDA personnel hold an applicant priefing for local and state officials to inform them of the public assistance available and the procedures and eligibility requirements involved. Items covered at the briefing include:

1. filing a Notice of Interest in receiving different types of federal disaster assistance;

2. preparing Damage Survey Reports (DSRs) to document damages and present repair costs;

3. filing a Project Application; and

4. addressing special considerations, such as environmental assessments and opportunities for hazard mitigation.

The Notice of Interest (see Figure B.1) is basically a checklist on which local and state officials identify the types of damage sustained by public facilities. It provides the basis by which FEMA schedules damage surveys.

Damage Survey Reports (see Figure B.2) document the extent of damages to different facilities, identify needed and eligible repairs, and assess in detail the costs of repairing or rebuilding them. The DSRs are prepared by a Damage Assessment Team consisting of federal state, and local personnel, and are submitted to FEMA and the Maryland EMCDA. The DSR is the basis for FEMA's

approval of applications for public assistance. The Damage Assessment Team depends on local officials' damage assessments to measure the severity and magnitude of damage; it is therefore very important for the local government to maintain accurate property records and conduct its own damage survey before the Damage Assessment Team arrives (Rogers, Golden, and Halpern, 1981, p. 4-23). Photographs, maps, and drawings are often included in the DSR to provide more complete descriptions and documentation.

FEMA classifies damages that are eligible for public assistance into seven categories of "permanent" work and two categories of "emergency" work (see Table B.1). A separate DSR is prepared for each category of work and for each damage site; separate DSRs are required for different categories of work at the same site.

A DSR does not constitute approval of repair work or a commitment of federal funds. It simply provides the most accurate information available on the extent of damages and estimated repair costs, which FEMA uses to approve or deny specific line items requested in the Project Application.

The Project Application (see Figure B.3) is the formal request for aid that a local government or state agency submits to FEMA's Regional Director through the Maryland EMCDA (or the Governor's Authorized Representative). The Project Application summarizes and combines the Damage Survey Reports for various repair projects for public facilities damaged in the community. The Project Application also provides the formal record of FEMA's and Maryland EMCDAs review and approval of the different projects for which federal funds are committed. The Project Application is signed by the applicant's authorized representative and is accompanied by a form designating this representative (see Figure B.4). The Project Application is also accompanied by the complete Damage Survey Report for each project listed. The application must be submitted to FEMA's Regional Director within 90 days of the Presidential declaration of a "major disaster"; the deadline is 30 days for an "emergency" declaration. Local officials should keep in mind that, under current FEMA policy, the federal government will only fund up to 75 percent of the eligible cost of repairs to public facilties.

Once a Project Application is approved and FEMA makes different forms of public assistance available to the local government or state agency, FEMA maintains standards for project administration. These include project completion deadlines, progress reports, and cost overruns. In a community where an "emergency has been declared, federal assistance typically ends one month after the initial Presidential declaration. Where a "major disaster" has been declared, federal assistance for "emergency" work typically ends six months after the declaration and federal assistance for "permanent" work ends after 18 months. Recipients of federal disaster aid can receive time extensions for a number of extenuating circumstances. Recipients must submit progress reports if there are any delays that would make a project run past the deadline or if the recipient faces cost overruns. FEMA or other federal and state agencies may conduct periodic inspections of selected projects to make sure that work is progressing in a timely fashion and according to the appropriate standards, policies, and procedures.

TABLE B.1: Categories of Public Assistance Available from FEMA

"Emergency" Work	"Permanent" Work
Debris Removal	Road or Street Systems
Emergency Protection (incl. Communications and public transportation)	Water Control Facilities
	Public Buildings and Related Equipment
	Public Utilities
	Facilities under Construction
	Private Nonprofit Facilities
	"Other"

As work on a project ends, the recipient notifies the Governor's Authorized Representative, who arranges for federal or state personnel to make a final inspection of the work in each category of funding (i.e. "emergency" or "permanent"). The Final Inspection Report (see Figure B.5) documents the completion of work and is essential to the recipient's being reimbursed for the cost of repairs. A project that does not exceed $10,000 usually does not require a final inspection.

Once the Final Inspection Report is completed and approved, the recipient files a Request for Reimbursement (see Figure B.6), attaching a listing of completed line items and their costs. This same form can be used to request advance payments as well as reimbursements. It is the final formal claim for the reimbursement of costs for all repair and reconstruction projects eligible and approved under FEMA's disaster assistance program.

Throughout the damage assessment/grant application/project administration/reimbursement process, it is essential for the local government to maintain detailed records. Records pertaining to damage assessment and repair costs should be well organized and contain accurate documentation. Damage Survey Reports should be accompanied by photographs, sketches, and property information (value, ownership, etc.); unsalvageable damaged equipment should even be retained for inspection by survey teams (FEMA, 1981, Documenting Disaster Damage, p. 5). Other records should be maintained to document repair costs that are contracted out or borne by the local government itself; this would include timesheets, equipment use schedules, and invoices should local staff and financial resources be expended for any project. These local expenditures may apply to the 25 percent match required of local and state governments under FEMA's public assistance program. (See FEMA's Document Disaster Damage, Report No. DR&R-7, for an excellent, brief discussion of record-keeping requirements and project application procedures).

In addition to funding local repair and reconstruction projects, the federal government may deploy its own personnel and equipment to perform emergency work if local and state personnel and equipment are inadequate to do so. To obtain this "direct" federal assistance, the local government or state

agency must submit a request to FEMA's RegionalDirector, via the Governor's Authorized Representative, within ten days after the Presidential declaration. The request takes the form of a resolution by the local governing body (or body governing a state agency) accompanied by a statement of why the work cannot be conducted with local or state resources. Local government budget constraints are not considered a sufficient cause for receiving direct federal assistance (FEMA, 1981, Handbook for Applicants, p. 5-1). FEMA's Regional Director will either approve or deny the request or, if the requested work falls under the mission of another federal agency,refer the request to that agency.

At the same time that local governments and state agencies are applying for federal disaster assistance, FEMA's Interagency Regional Hazard Mitigation Team conducts its analysis of damages in the community, identifies opportunities for hazard mitigation, and issues its report recommending certain actions for federal, state, and local agencies. Also, under the requirements of Section 406 of the Federal Disaster Relief Act, the state must evaluate all hazards in the state and areas affected by the current disaster, and prepare a Section 406 Hazard Mitigation Plan, including specific recommendations for hazard mitigation measures.

If there is no Presidential declaration, certain types of federal disaster assistance are still made available to the community. The procedures for receiving such aid vary, as these programs are administered by separate federal agencies. FEMA plays less of a coordinating function when there is no Presidential declaratioon.

Figure B.7 illustrates the timetable under which FEMA's disaster assistance procedures operate. It includes deadlines for damage surveys, project applications, and project completion.

Figure B.1: FEMA Notice of Interest Form

Form Approved
OMB No. 026-R0036

FEDERAL EMERGENCY MANAGEMENT AGENCY
DISASTER RESPONSE AND RECOVERY

NOTICE OF INTEREST

IN APPLYING FOR FEDERAL DISASTER ASSISTANCE

FEMA DECLARATION NUMBER

DATE

FIPS NUMBER

The purpose of this form is to list the damages to property and facilities so that inspectors may be appropriately assigned for a formal survey.

REQUIREMENTS FOR FEDERAL DAMAGE SURVEYS

A. DEBRIS CLEARANCE

- ☐ On Public Roads & Streets including ROW
- ☐ Other Public Property
- ☐ Private Property *(When undertaken by local Government forces)*
- ☐ Structure Demolition

B. PROTECTIVE MEASURES

- ☐ Life and Safety ☐ Health
- ☐ Property ☐ Stream/Drainage Channels

C. ROAD SYSTEMS

- ☐ Roads ☐ Streets
- ☐ Bridges ☐ Culverts
- ☐ Traffic Control ☐ Other*

D. WATER CONTROL FACILITIES

- ☐ Dikes ☐ Levees ☐ Dams
- ☐ Drainage Channels ☐ Irrigation Works

E. PUBLIC BUILDINGS AND EQUIPMENT

- ☐ Public Buildings
- ☐ Supplies or inventory
- ☐ Vehicles or other equipment
- ☐ Transportation Systems
- ☐ Higher Education Facilities

F. PUBLIC UTILITY SYSTEMS

- ☐ Water ☐ Storm Drainage
- ☐ Sanitary Sewerage ☐ Light/Power
- ☐ Other*

G. FACILITIES UNDER CONSTRUCTION

- ☐ Public Facilities*
- ☐ Private Non-Profit Facilities**

H. PRIVATE NON-PROFIT FACILITIES**

- ☐ Educational ☐ Medical
- ☐ Emergency ☐ Custodial Care
- ☐ Utility

I. OTHER *(Not in above categories)*

- ☐ Park Facilities
- ☐ Recreational Facilities

* *Indicate type of facility;*
** *Provide name of the facility and of private non-profit owner.*

NAME AND TITLE OF REPRESENTATIVE WHO WILL ACCOMPANY THE SURVEY TEAM

NAME OF POLITICAL SUBDIVISION OR ELIGIBLE APPLICANT 1 | COUNTY 2

BUSINESS ADDRESS | ZIP CODE

BUSINESS TELEPHONE *(Area Code/Number)* 3 | HOME TELEPHONE *(Area Code/Number)*

APPLICANT'S AUTHORIZED REPRESENTATIVE 4 | BUSINESS TELEPHONE *(Area Code/Number)*

FEMA FORM 90-49 (3/80)

Source: FEMA, 1981, Handbook for Applicants, p. E-1.

Figure B.2: FEMA Damage Survey Report Form

Form Approved
OMB No. 3067-0027

FEDERAL EMERGENCY MANAGEMENT AGENCY
- DAMAGE SURVEY REPORT
DISASTER RESPONSE AND RECOVERY
(See instructions on reverse)

3. DECLARATION NO. FEMA

4. INSPECTION DATE

1. TO ➡ REGION _____ FEDERAL EMERGENCY MANAGEMENT AGENCY

5. WORK ACCOMPLISHED BY
☐ CONTRACT
☐ FORCE ACCOUNT

2. APPLICANT *(State Agency, County, City, etc.)* | PA NO.

7. WORK CATEGORY *("X" Applicable Box)*
☐ EMERGENCY ☐ A ☐ B
☐ PERMANENT ☐ C ☐ D ☐ E ☐ F ☐ G ☐ H ☐ I

DSR NO. 100001

6. PERCENTAGE OF WORK COMPLETED TO DATE
%

8. DAMAGED FACILITIES *(Location, identification and description)*

8A. FACILITY IN OR AFFECTS FLOOD PLAIN OR WET LANDS
☐ YES ☐ NO

9. DESCRIPTION OF DAMAGE

10. SCOPE OF PROPOSED WORK

11. ESTIMATED COST OF PROPOSED WORK

QUANTITY (a)	UNIT (b)	MATERIAL AND/OR DESCRIPTION (c)	UNIT PRICE (d)	COST *(dollars)* (e)

12. EXISTING INSURANCE *(Type)* | AMOUNT $ | TOTAL ➡ $

13. RECOMMENDATION BY FEDERAL INSPECTOR *(Signature, Agency, date)*	ELIGIBLE ☐ YES ☐ NO	ATTACHMENTS
14. CONCURRENCE IN REPORT BY STATE INSPECTOR *(Signature, Agency, date)*	CONCUR ☐ YES ☐ NO	ATTACHMENTS
15. CONCURRENCE IN REPORT BY LOCAL REPRESENTATIVE *(Signature, Agency, date)*	CONCUR ☐ YES ☐ NO	ATTACHMENTS

16. FEDERAL REVIEW *(Signature, Agency, date)* | FEMA REVIEW *(Initials and date)*

FEMA Form 90-52, JAN 81 (Formerly HUD Form 484)

COPY 1 - FEMA REGION

Source: FEMA, 1981, Handbook for Applicants, p. F-1.

TABLE B.1: Categories of Public Assistance Available from FEMA

"Emergency" Work	"Permanent" Work
Debris Removal	Road or Street Systems
Emergency Protection (incl. Communications and public transportation)	Water Control Facilities
	Public Buildings and Related Equipment
	Public Utilities
	Facilities under Construction
	Private Nonprofit Facilities
	"Other"

As work on a project ends, the recipient notifies the Governor's Authorized Representative, who arranges for federal or state personnel to make a final inspection of the workin each category of funding (i.e. "emergency" or "permanent"). The Final Inspection Report (see Figure B.5) documents the completion of work and is essential to the recipient'sbeing reimbursed for the cost of repairs. A project that does not exceed $10,000 usually does not require a final inspection.

Once the Final Inspection Report is completed and approved, the recipient files a Request for Reimbursement (see Figure B.6), attaching a listing of completed liner items and their costs. This same form can be used to request advance payments as well as reimbursements. It is the final formal claim for the reimbursement of costs for all repair and reconstruction projects eligible and approved under FEMA's disaster assistance program.

Throughout the damage assessment/grant application/project administration/reimbursement process, it is essential for the local government to maintain detailed records. Records pertaining to damage assessment and repair costs should be well organized and contain accurate documentation. Damage Survey Reports should be accompanied by photographs, sketches, and property information (value, ownership, etc.); unsalvageable damaged equipment should even be retained for inspection by survey teams (FEMA, 1981, Documenting Disaster Damage, p. 5). Other records should be maintained to document repair costs that are contracted out or borne by the local government itself; this would include timesheets, equipmentuse schedules, and invoices should local staff andinancial resources be expended for any project. These local expenditures may apply to the 25 percent match required of local and state governments under FEMA's public assistance program. (See FEMA's Document DisasterDamage, Report No. DR&R-7, for an excellent, brief discussion of record-keeping requirements and project application procedures).

In addition to funding local repair and reconstruction projects, the federal government may deploy its own personnel and equipment to perform emergency work if local and state personnel and equipment are inadequate to do so. To obtain this "direct" federal assistance, the local government or state

approval of applications for public assistance. The Damage Assessment Team depends on local officials' damage assessments to measure the severity and magnitude of damage; it is therefore very important for the local government to maintain accurate property records and conduct its own damage survey before theDamage Assessment Team arrives (Rogers, Golden, and Halpern, 1981, p. 4-23). Photographs, maps, and drawings are often included in the DSR to provide more complete descriptions and documentation.

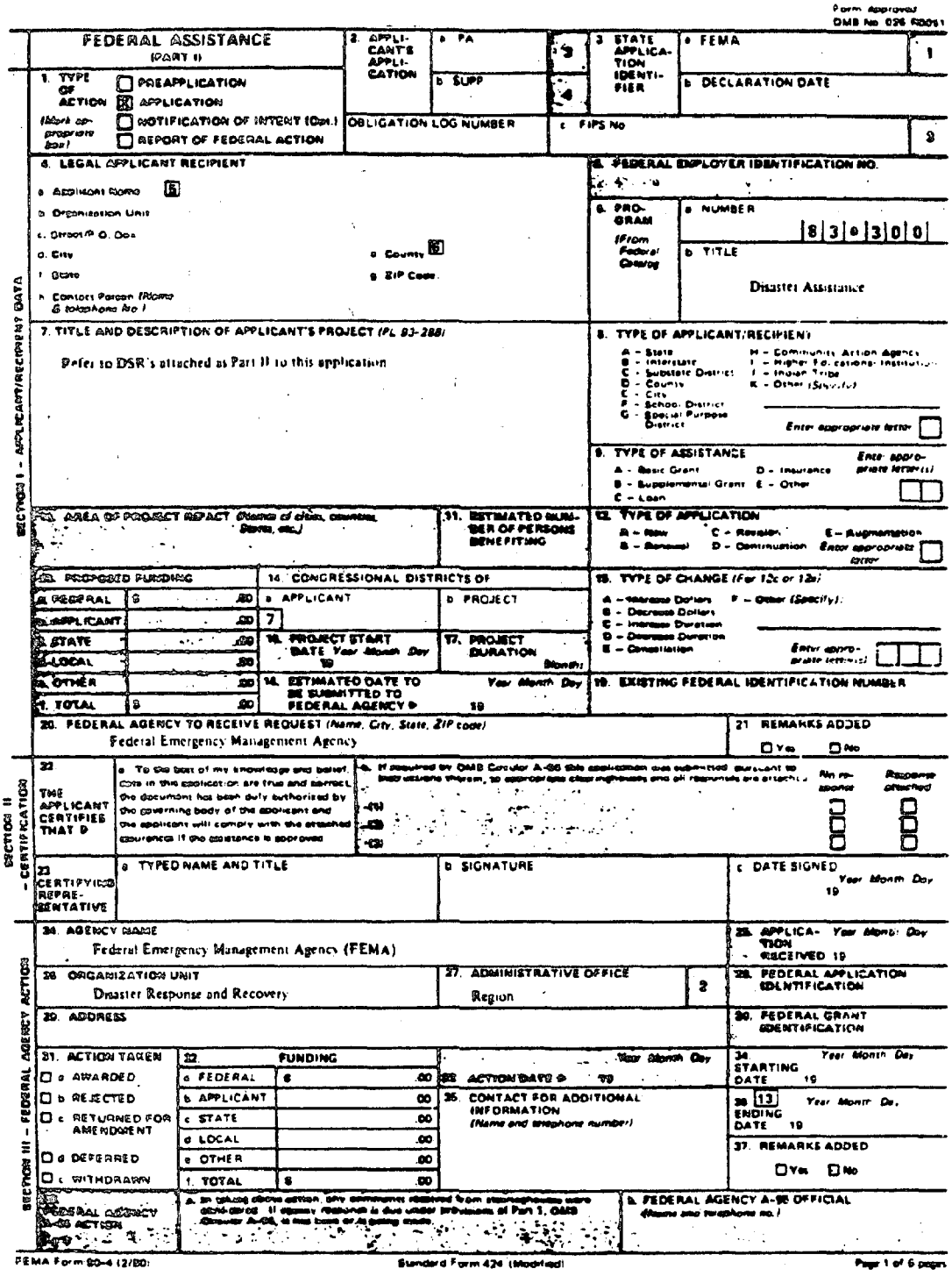
FEMA classifies damages that are eligible for public assistance into seven categories of "permanent" work and two categories of "emergency" work (see Table B.1). A separate DSR is prepared for each category of work and for each damage site; separate DSRs are required for different categories of work at the same site.

A DSR does not constitute approval of repair work or a commitment of federal funds. It simply provides the most accurate information available on the extent of damages and estimated repair costs, which FEMA uses to approve or deny specific line items requested in the Project Application.

The Project Application (see Figure B.3) is the formal request for aid that a local government or state agency submits to FEMA's Regional Director through the Maryland EMCDA (or the Governor's Authorized Representative). The Project Application summarizes and combines the Damage Survey Reports for various repair projects for public facilities damaged in the community. The Project Application also provides the formal record of FEMA's and Maryland EMCDAs review and approval of the different projects for which federal funds are committed. The Project Application is signed by the applicant's authorized representative and is accompanied by a form designating this representative (see Figure B.4). The Project Application is also accompanied by the complete Damage Survey Report for each project listed. The application must be submitted to FEMA's Regional Director within 90 days of the Presidential declaration of a "major disaster"; the deadline is 30 days for an "emergency" declaration. Local officials should keep in mind that, under current FEMA policy, the federal government will onlyfund up to 75 percent of the eligible cost of repairs to public facilties.

Once a Project Application is approved and FEMA makes different forms of public assistance available to thelocal government or state agency, FEMA maintains standards for project administration. These include project completion deadlines, progress reports, and cost overruns. In a community where an "emergency has been declared, federal assistance typically ends one month after the initial Presidential declaration. Where a "major disaster" has been declared, federal assistance for "emergency" work typically ends six months after the declaration and federal assistance for "permanent" work ends after 18 months. Recipients of federal disaster aid can receive time extensions for a number of extenuating circumstances. Recipients must submit progress reports if there are any delays that would make a project run past the deadline or if the recipient faces cost overruns. FEMA or other federal and state agencies may conduct periodic inspections ofselected projects to make sure that work is progressing in a timely fashion and according to the appropriate standards, policies, and procedures.

Figure B.3: FEMA Project Application Form



Form Approved
OMB No. 026 R0051

FEDERAL ASSISTANCE (PART I)

1. TYPE OF ACTION: ☐ PREAPPLICATION ☒ APPLICATION ☐ NOTIFICATION OF INTENT (Opt.) ☐ REPORT OF FEDERAL ACTION (Mark appropriate box)

2. APPLICANT'S APPLICATION: a. PA; b. SUPP; OBLIGATION LOG NUMBER

3. STATE APPLICATION IDENTIFIER: a. FEMA 1; b. DECLARATION DATE

c. FIPS No. 3

SECTION I – APPLICANT/RECIPIENT DATA

4. LEGAL APPLICANT/RECIPIENT
a. Applicant Name 5
b. Organizational Unit
c. Street/P. O. Box
d. City
e. County 6
f. State
g. ZIP Code
h. Contact Person (Name & telephone No.)

4a. FEDERAL EMPLOYER IDENTIFICATION NO.

5. PROGRAM (From Federal Catalog): a. NUMBER 8 3 0 3 0 0; b. TITLE: Disaster Assistance

7. TITLE AND DESCRIPTION OF APPLICANT'S PROJECT (PL 93-288)
Refer to DSR's attached as Part II to this application

8. TYPE OF APPLICANT/RECIPIENT
A – State; B – Interstate; C – Substate District; D – County; E – City; F – School District; G – Special Purpose District; H – Community Action Agency; I – Higher Education Institution; J – Indian Tribe; K – Other (Specify)
Enter appropriate letter ☐

9. TYPE OF ASSISTANCE
A – Basic Grant; B – Supplemental Grant; C – Loan; D – Insurance; E – Other
Enter appropriate letter(s) ☐☐

10. AREA OF PROJECT IMPACT (Names of cities, counties, States, etc.)

11. ESTIMATED NUMBER OF PERSONS BENEFITING

12. TYPE OF APPLICATION
A – New; B – Renewal; C – Revision; D – Continuation; E – Augmentation
Enter appropriate letter ☐

13. PROPOSED FUNDING

a. FEDERAL	$ .00
b. APPLICANT	.00
c. STATE	.00
d. LOCAL	.00
e. OTHER	.00
f. TOTAL	$ .00

14. CONGRESSIONAL DISTRICTS OF: a. APPLICANT 7; b. PROJECT

15. PROJECT START DATE (Year Month Day): 19

16. PROJECT DURATION (Months)

17. ESTIMATED DATE TO BE SUBMITTED TO FEDERAL AGENCY (Year Month Day): 19

18. TYPE OF CHANGE (For 12c or 12e)
A – Increase Dollars; B – Decrease Dollars; C – Increase Duration; D – Decrease Duration; E – Cancellation; F – Other (Specify)
Enter appropriate letter(s) ☐☐☐

19. EXISTING FEDERAL IDENTIFICATION NUMBER

20. FEDERAL AGENCY TO RECEIVE REQUEST (Name, City, State, ZIP code)
Federal Emergency Management Agency

21. REMARKS ADDED ☐ Yes ☐ No

SECTION II – CERTIFICATION

22. THE APPLICANT CERTIFIES THAT
a. To the best of my knowledge and belief, data in this application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved.
b. If required by OMB Circular A-95 this application was submitted pursuant to State clearinghouse process, the appropriate clearinghouse(s) and all responses are attached. (1) (2) (3) — No response ☐ — Response attached ☐

23. CERTIFYING REPRESENTATIVE: a. TYPED NAME AND TITLE; b. SIGNATURE; c. DATE SIGNED (Year Month Day): 19

SECTION III – FEDERAL AGENCY ACTIONS

24. AGENCY NAME
Federal Emergency Management Agency (FEMA)

25. APPLICATION RECEIVED (Year Month Day): 19

26. ORGANIZATION UNIT
Disaster Response and Recovery

27. ADMINISTRATIVE OFFICE
Region 2

28. FEDERAL APPLICATION IDENTIFICATION

29. ADDRESS

30. FEDERAL GRANT IDENTIFICATION

31. ACTION TAKEN
☐ a. AWARDED
☐ b. REJECTED
☐ c. RETURNED FOR AMENDMENT
☐ d. DEFERRED
☐ e. WITHDRAWN

32. FUNDING

a. FEDERAL	$ .00
b. APPLICANT	.00
c. STATE	.00
d. LOCAL	.00
e. OTHER	.00
f. TOTAL	$ .00

33. ACTION DATE (Year Month Day): 19

34. STARTING DATE (Year Month Day): 19

35. CONTACT FOR ADDITIONAL INFORMATION (Name and telephone number)

36. 13 ENDING DATE (Year Month Day): 19

37. REMARKS ADDED ☐ Yes ☐ No

38. FEDERAL AGENCY A-95 ACTION
a. In taking above action, any comments received from clearinghouses were considered. If agency response is due under provisions of Part 1, OMB Circular A-95, or was based on an existing award.
b. FEDERAL AGENCY A-95 OFFICIAL (Name and telephone no.)

FEMA Form 90-4 (2/80) Standard Form 424 (Modified) Page 1 of 6 pages

Source: FEMA, 1981, Handbook for Applicants, p. G-1.

Figure B.3: FEMA Project Application Form (continued)

39a. PART I *(Continued)* FEMA Agreement No. _____ P.A. No. _____ Sup. No. _____

39b. Project Summary *(Based on Part II of this application)*

	AMOUNT REQUESTED BY APPLICANT	AMOUNT APPROVED BY STATE	AMOUNT APPROVED BY FEMA
A. Debris Clearance			
B. Protective Measures			
C. Road Systems			
D. Water Control Facilities			
E. Public Buildings and Equipment			
F. Public Utilities			
G. Facilities Under Construction			
H. Private Nonprofit Facilities			
I. Other Damages *(Not included in above categories)*			
TOTAL			

40. Funding *(please check)*

	APPLICANT REQUEST	STATE APPROVAL	FEMA APPROVAL
Small Project Grant *(In-lieu Contribution)*	☐	☐	☐
Flexible Funding Grant	☐	☐	☐
Advance of Funds	☐	☐	☐
Categorical Grant	☐	☐	☐
Advance of Funds	☐	☐	☐

41. Approved by Governor's Authorized Representative

_____ _____ _____

(Date Received) *(Date Approved)* *(Signature)*

42. Approved by FEMA

_____ _____ _____

(Date Received) *(Date Approved)* *(Signature)*

43. Remarks *(Reference application Part and Item Number as appropriate. Attach additional sheets when necessary).*

44. **PART II - PROGRAM NARRATIVE**

(Attach Damage Survey Reports (FEMA Form 90-52) to document fully and support this application)

Figure B.4: FEMA Applicant's Agent Designation Form

DESIGNATION OF APPLICANT'S AGENT

RESOLUTION

BE IT RESOLVED BY _____ OF _____.
(Governing Body) *(Public Entity)*

THAT _____ , _____
☆ *(Name of Incumbent)* *(Official Position)*

OR

_____ , Governor's Authorized Representative,
☆ *(Name of Incumbent)*

is hereby authorized to execute for and in behalf of _____

_____ , a public entity established under the laws of the State of _____ , this application and to file it in the appropriate State office for the purpose of obtaining certain Federal financial assistance under the Disaster Relief Act (Public Law 288, 93rd Congress) or otherwise available from the President's Disaster Relief Fund.

THAT _____ , a public entity established under the laws of the State of _____ , hereby authorizes its agent to provide to the State and to the Federal Emergency Management Agency (FEMA) for all matters pertaining to such Federal disaster assistance the assurances and agreements printed on the reverse side hereof.

Passed and approved this _____ day of _____ , 19 ____.

_____
(Name and Title)

_____
(Name and Title)

_____
(Name and Title)

CERTIFICATION

I, _____ , duly appointed and _____ of
(Title)

_____ , do hereby certify that the above is a true and correct copy of a resolution passed and approved by the _____ of _____
(Governing Body) *(Public Entity)*

on the _____ day of _____ , 19 ____.

Date: _____

_____ _____
(Official Position) *(Signature)*

☆Name of incumbent need not be provided in those cases where the governing body of the public entity desires to authorize any incumbent of the designated official position to represent it.

FEMA Form 90-49, MAR 81

Source: FEMA, 1981, Handbook for Applicants, p. H-1.

Figure B.5: FEMA Final Inspection Report Form

Form Approved
OMB No.
3225-R0003

FEDERAL EMERGENCY MANAGEMENT AGENCY
DISASTER RESPONSE AND RECOVERY
· FINAL INSPECTION REPORT

DECLARATION NUMBER AND DATE

APPLICATION NO. | SUPPLEMENT NO.

TO: FEDERAL EMERGENCY MANAGEMENT AGENCY REGION

FROM: *(Agency and/or Bureau and Location)*

1. APPLICANT

2. TYPE OF FUNDING: ☐ CATEGORICAL ☐ FLEXIBLE ☐ SMALL PROJECT GRANT

3. INSPECTED WORK

CAT.	ITEM	DATE COMPLETED	DATE INSPECTED	INSURANCE SETTLEMENT	APPROVED PA COST ESTIMATE	REPORTED COST	CONTRACT/ FORCE ACCT.	SCOPE OF WORK *(Report Changes)*

4. INSPECTOR

	STATE		FEDERAL	
	YES	NO	YES	NO
a. Did you personally inspect each item of completed work?				
b. Did you review and utilize applicable Damage Survey Reports?				
c. Did you review and utilize applicable FEMA Engineering Analyses?				
d. Did you review and utilize applicable Applicant's Documentation?				
e. Did you ever make any prior inspections of any of these work items?				

CERTIFICATION

The above item(s) in the project application for the category of work shown has been inspected and certification is hereby made that the work has been completed as approved therein, except as noted above.

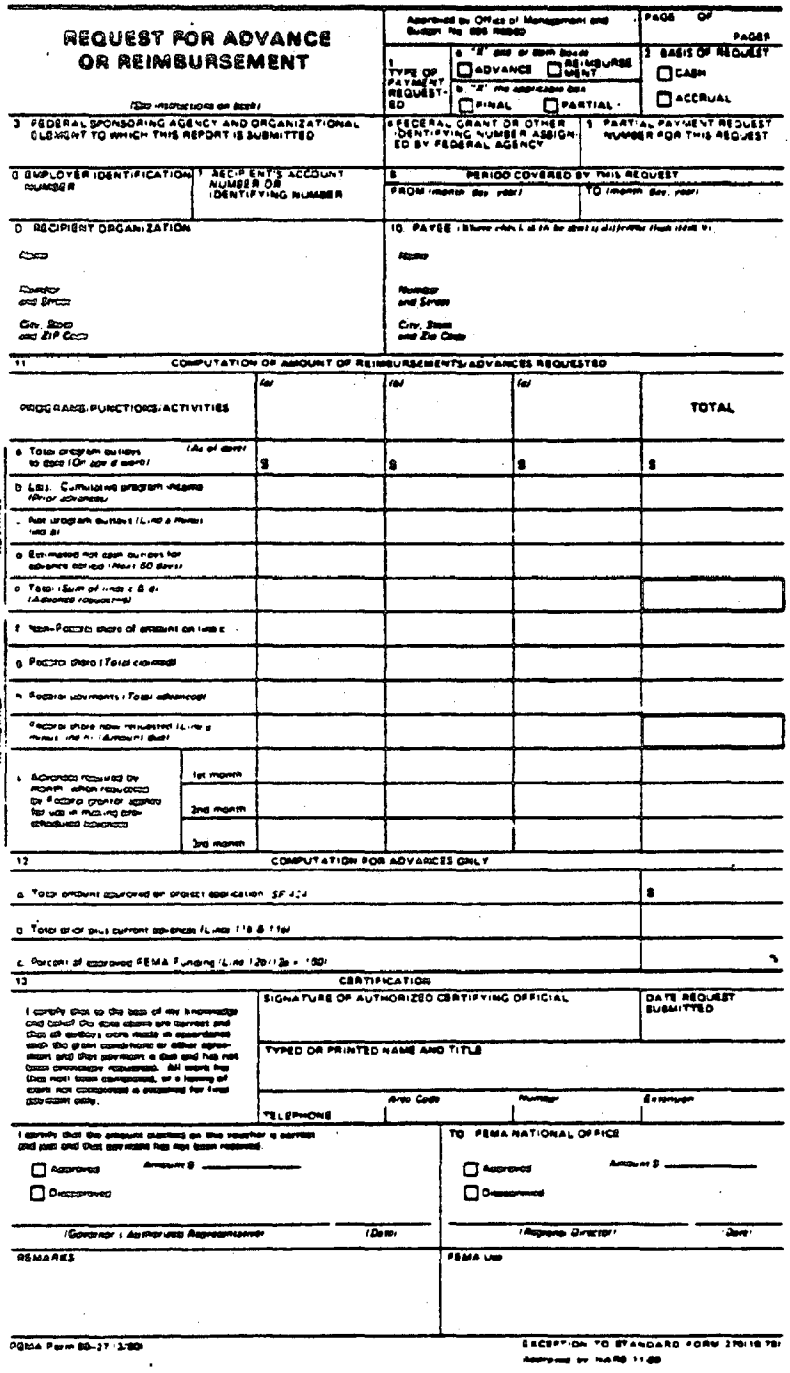
FEDERAL INSPECTOR *(Signature and Title) (Federal Agency)*	*(Date)*	FEMA REVIEW
STATE INSPECTOR *(Signature and Title) (State Agency)*	*(Date)*	INITIALS
LOCAL REPRESENTATIVE *(Signature and Title)*	*(Date)*	DATE

FEMA FORM 90-43 (3/80)

Sheet _____ of _____

Source: FEMA, 1981, Handbook for Applicants, p. K-1.

Figure B.6: FEMA Request for Reimbursement Form



REQUEST FOR ADVANCE OR REIMBURSEMENT

(See instructions on back)

Approved by Office of Management and Budget No. 686-R0003

PAGE OF PAGES

1 TYPE OF PAYMENT REQUESTED — a "X" one or both boxes: ☐ ADVANCE ☐ REIMBURSEMENT; b "X" one applicable box: ☐ FINAL ☐ PARTIAL

2 BASIS OF REQUEST: ☐ CASH ☐ ACCRUAL

3 FEDERAL SPONSORING AGENCY AND ORGANIZATIONAL ELEMENT TO WHICH THIS REPORT IS SUBMITTED

4 FEDERAL GRANT OR OTHER IDENTIFYING NUMBER ASSIGNED BY FEDERAL AGENCY

5 PARTIAL PAYMENT REQUEST NUMBER FOR THIS REQUEST

6 EMPLOYER IDENTIFICATION NUMBER

7 RECIPIENT'S ACCOUNT NUMBER OR IDENTIFYING NUMBER

8 PERIOD COVERED BY THIS REQUEST — FROM (month day year) TO (month day year)

9 RECIPIENT ORGANIZATION — Name; Number and Street; City, State and ZIP Code

10 PAYEE (Show only if different than item 9) — Name; Number and Street; City, State and ZIP Code

11 COMPUTATION OF AMOUNT OF REIMBURSEMENT/ADVANCES REQUESTED

PROGRAMS/FUNCTIONS/ACTIVITIES	(a)	(b)	(c)	TOTAL
a. Total program outlays to date (As of date)	$	$	$	$
b. Less: Cumulative program income				
c. Net program outlays (Line a minus line b)				
d. Estimated net cash outlays for advance period (Next 60 days)				
e. Total (Sum of lines c & d) (Advance requested)				
f. Non-Federal share of amount on line e				
g. Federal share (Total earned)				
h. Prior payments (Total advanced)				
i. Federal share now requested (Line g minus line h) (Amount due)				
j. Advances received by month when requested by Federal grantor agency for use in making disbursements — 1st month				
2nd month				
3rd month				

ADVANCE / REIMBURSE

12 COMPUTATION FOR ADVANCES ONLY

a. Total amount approved on project application SF 424 — $

b. Total amt of this current submission (Line 11 e (a))

c. Percent of approved FEMA funding (Line 12b / 12a = %)

13 CERTIFICATION

I certify that to the best of my knowledge and belief the data above are correct and that all outlays were made in accordance with the grant conditions or other agreement and that payment is due and has not been previously requested. All work has (has not) been completed, or a lesser of work not completed is proposed for final payment only.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL — DATE REQUEST SUBMITTED

TYPED OR PRINTED NAME AND TITLE

TELEPHONE (Area Code, Number, Extension)

I certify that the amounts payable on this voucher is correct and proper and that services has not been rendered.

☐ Approved Amount $ _____

☐ Disapproved

(Governor / Authorized Representative) (Date)

TO FEMA NATIONAL OFFICE

☐ Approved Amount $ _____

☐ Disapproved

(Regional Director) (Date)

REMARKS

FEMA Use

FEMA Form 85-27 (3-80)

EXCEPTION TO STANDARD FORM 270 (10-79)

Approved by GSA/FPMR 41 CFR

Source: FEMA, 1981, Handbook for Applicants, p. I-1.

agency must submit a request to FEMA's RegionalDirector, via the Governor's Authorized Representative, within ten days after the Presidential declaration. The request takes the form of a resolution by the local governing body (or body governing a state agency) accompanied by a statement of why the work cannot be conducted with local or state resources. Local government budget constraints are not considered a sufficient cause for receiving direct federal assistance (FEMA, 1981, Handbook for Applicants, p. 5-1). FEMA's Regional Director will either approve or deny the request or, if the requested work falls under the mission of another federal agency,refer the request to that agency.

At the same time that local governments and state agencies are applying for federal disaster assistance, FEMA's Interagency Regional Hazard Mitigation Team conducts its analysis of damages in the community, identifies opportunities for hazard mitigation, and issues its report recommending certain actions for federal, state, and local agencies. Also, under the requirements of Section 406 of the Federal Disaster Relief Act, the state must evaluate all hazards in the state and areas affected by the current disaster, and prepare a Section 406 Hazard Mitigation Plan, including specific recommendations for hazard mitigation measures.

If there is no Presidential declaration, certain types of federal disaster assistance are still made available to the community. The procedures for receiving such aid vary, as these programs are administered by separate federal agencies. FEMA plays less of a coordinating function when there is no Presidential declaratioon.

Figure B.7 illustrates the timetable under which FEMA's disaster assistance procedures operate. It includes deadlines for damage surveys, project applications, and project completion.

Figure B.7: Timing of Federal Disaster Assistance Activities

Activity	Days 0	15	30	45	90 (3 mos)	105	180 (6 mos)	540 (18 mos)
Disaster Event	x							
Preliminary Damage Assessment	———							
Pres. Declaration	x							
Establishment of Field Offices & Applicant Briefings	——							
Damage Survey Reports	———	———	———	———	———			
Project Applications and Approvals*	———	———	———	———	———			
Project Completion & Final Inspection:								
"Emergency" work		———	———	———	———	———	———	
"Permanent" work		———	———	———	———	———	———	———
Interagency Reg. Haz. Mitigation Team								
Recommendations	———							
Progress Report		———	———	———	———	———		
Section 406 Planning								
Survey	———	———	———	———	———	———	———	
Plan				———	———	———	———	

*Thirty-day deadline if only an "emergency" is declared, not a "major disaster."

Adapted from: FEMA, 1981, Flood Hazard Mitigation: Handbook of Common Procedures, p. I-5.

APPENDIX C

Glossary

GLOSSARY

BLL - Building Limit Line
BOCA - Building Officials Code Administration
CoBRA - Coastal Barrier Resources Act
COE - U.S. Army Corps of Engineers
CZMA - Coastal Zone Management Act
DNR - Department of Natural Resources (State of Maryland)
EPA - U.S. Environmental Protection Agency
FEMA - Federal Emergency Management Agency
FIRM - Flood Insurance Rate Map
FIS - Flood Insurance Study
MGS - Maryland Geological Survey
MHW - mean high water
MLW - mean low water
MSL - Mean Sea Level
NFIP - National Flood Insurance Program
NGVD - National Geodetic Vertical Datum
NOAA - National Oceanic and Atmospheric Administration
NOS - National Ocean Survey
WRA - Water Resources Administration (State of Maryland)

APPENDIX D

Additional Recommendations and Research Needs

WORCESTER COUNTY RECOMMENDATIONS

1. The County Commissioners should adopt a uniform building code to ensure that new construction and reconstruction is performed in accordance with currently accepted practices, including accepted practices for construction in flood prone areas and areas subject to high winds (hurricanes). It is recommended that the County adopt either the Standard Building Code (as used in Ocean City) and in most areas south of Maryland, or the BOCA code which is used in most eastern U.S. locations from Virginia and Maryland north.

2. The County Commissioners should adopt a stormwater management ordinance as required by the State of Maryland.

3. The current zoning map should be reviewed for conformance with the Worcester County Comprehensive Plan, especially with regard to zoning of land fronting on the various bays. The Comprehensive Plan (1976) recommends that almost all of the bayfront property be zoned for "Conservation", with very limited development. The existing zoning map has a much greater portion of the bayfront property zoned for various residential and commercial uses than is recommended in the Comprehensive Plan. To the extent possible (areas that are not already developed), zoning of bayfront areas should be "Conservation" as recommended in the Comprehensive Plan.

4. The County Commissioners should enact a setback from tidal (and freshwater) wetlands. Construction and other activities should be permitted within an established setback zone only if there will be no adverse impact on the wetlands and if the use is necessary for access to the waterfront. Such a provision should reduce the practice of development directly on the bayfront and construction of bulkheads that alter the natural land/water interface.

5. Worcester County should join with Ocean City in the development of a detailed emergency preparedness plan, including evaluation of existing evacuation routes, emergency evacuation procedures, and provision of emergency shelters for both area residents and transients.

WATERSHED MANAGEMENT STUDY RECOMMENDATIONS

1. An existing land use map should be prepared, based on the most recent available aerial photographs, with a windshield survey ground check. A suitable minimum area of land use category delineation should be established, i.e. 5 acres.

2. Study area boundaries should be identified and mapped, including an accurate delineation of watershed boundaries on the north, west, and south extent of the study area (including drainage areas that extend into Delaware).

3. Erosion and Flood control structures along the bays:
   a. Inventory, map and describe bhe existing, major bulkheads, canals and other structures, including approximate date of construction, methods of construction,maintenance, current conditions.
   b. Evauate the existing condition of these structures, their ability to withstand a major storm, their effectiveness in preventing erosion and flooding, estimated future life, and recommended maintenance procedures.

4. Review activities in the State of Delaware immediately adjacent to the study area boundaries and within watersheds draining to the study area that may impact the study areas, inlcuding structural and nonstructural measures affecting floodplain management.

5. Emergency Preparedness
   a. Transportation Routes
      - Identify sections of main transportation (evacuation) routes that are likely to be flooded at different times during a major storm (within limits possible without development of a SLOSH model).
      - Determine the traffic carrying capacity of the existing evacuation routes.
      - Identify roads or sections of roads that are inadequate to meet evacuation needs
      - Identify alternatives for resolving identified problems with emergency evacuation routes

SCIENTIFIC RESEARCH NEEDS

Land use control changes that have been recommended in this planning study are directly related to changes that occur to the natural and built environments as a result of coastal storms or longer term coastal processes. The nonstructural response to increased flood hazard vulnerability must be based on the knowledge of these physical changes and that knowledge can only be gained through timely and adequate monitoring of these changes. Over a five year period or after a storm event, the changes in nearshore slope, beach and dunes can be documented and used to justify changes in land use.

Knowledge of additional geoloic and hydrographic conditions are important in predicting changes that may occur in the long-term future. Such conditions do not change readily enough to monitor and cannot be used to base changes in specific land use controls. The following list is a set of recommendations for obtaining continued and new scientific data. In general, the work is recommended to begin in 1985 and continue on a five-year basis. Any new or original data should be colleted before 1985.

1. Determine the position of the MHW contour -10 foot contour and -20 foot contour in 1985 with respect to their position in 1965. This information will provide an update of the changes in nearshore slope and whether further steepening has occurrd which places the barrier in a more vulnerable situation.

2. Determine the change in position of Mean High Water with respect to the Building Limit Line (BLL) on a five-year basis or after a storm occurs.

3. Establish a beach profile monitoring program and maintain an understanding of volumetric changes on an annual basis.

4. Determine flood hazard zones like that predicted in the 1983 Flood Insurance Study on a five-year basis or after a storm occurs.

5. Determine flood hazard zones along the bay shoreline of Ocean City presuming that equal forces of a storm will be generated from the northwest after the storm center has passed northward.

6 Determine the three-dimensional stratigraphy of the barrier. This would aid in the prediction of long-term shoreline dynamics and coastal flood hazards.

7. Determine realistic sea level rise values for the Ocean City/ Worcester County area.